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PHYSIOLOGIC RACES OF *PELLICULARIA SASAKII* IN TAIWAN(1)

by

C. C. CHIEN and S. C. JONG(2)

Sheath blight disease incited by *Pellicularia sasakii* on rice plants is of the second importance to blast in distribution as well as damage for the rice culture in Taiwan (Hashioka 1951). Under the present situation in Taiwan, the *japonica* type of rice is more susceptible. Yield loss from this disease is around 14–17% (Lo 1961). According to Lo (Personal communication), the loss due to the blast disease might have been exceeded by the sclerotial sheath blight which has become increasingly prevalent in recent years (Chiu 1962).

Sawada (1912) stated that the fungus might be able to infect a diverse number of plants, 47 species belonging to 4 families in Taiwan; 60 species belonging to 16 families in Japan. Matsumoto (1934) reported that there were 16 strains of the fungus collected in Taiwan from various hosts, including rice, sugarcane, groundnut, french bean, cowpea and camphor. Nakada and Kawamura (1939) pointed out that there were 16, 9 and 3 biotypes observed according to the cultural characteristics of the fungus on Czapek's, Potato sucrose and dried plum agar, respectively. They also stated that the suscepts attacked by this parasite were about 188 species of 32 families in Japan.

In consideration of the information stated above, one can presume the existence of many physiologic races of the fungus in nature. For this reason an attempt on studies of the feasible existence of different races in Taiwan have been made in Department of Plant Pathology at Taiwan Agricultural Research Institute since 1957.

In the present paper, experimental evidence confirmed the existence of physiologic races of *P. sasakii* in Taiwan.

Materials and Methods

A sclerotium was put on the center of 2 per cent agar plate. After incubation at 28°C for one day, a small piece of agar containing a single hypha was cut out and transplanted individually to potato sucrose agar plate for identifying the cultural type.

In the inoculation tests, the original isolate was transferred to a 125 cc flask

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(2) Associate Plant Pathologist and Junior Plant Pathologist of Taiwan Agricultural Research Institute respectively.

with rice culm medium containing 2% glucose. Flask culture was incubated at 28°C for 10 days to obtain enough sclerotia for inoculation.

To determine the pathogenicity of different isolates of *P. sasakii*, inoculations were made in the green house on 16 differential varieties of rice growing separately in fungus free soil in an iron flat (20 cm × 20 cm in size). Prior to the inoculation, 2% ammonium sulfate solution was top-dressed to the flats twice, at the rate of 25 cc per flat for each application. When the seedlings reach at five leaves stage, they were inoculated on the base of them with cultured cut culms containing sufficient amount of sclerotia and hyphae. After inoculation, the plants were kept for 2 days under a polythelene sheet supported by a wooden frame, humidity being maintained over 90%. In the greenhouse, the present experiment was done at a temperature range from 28° to 32°C. Reading of the plant reactions was made as soon as the infected sheath could be distinguished, usually in 8 to 12 days after inoculation, depending on the environmental conditions.

Infection types shown on the 16 differential varieties were characterized as follows:

Type 0: immune, no infection observed.
Type 1: infection appearing only on 1st leaf-sheath.
Type 2: infection appearing on 1st and 2nd leaf-sheeths.
Type 3: infection appearing on 1st to 3rd leaf-sheaths.
Type 4: infection appearing on 1st to 4th leaf-sheaths.
Type 5: infection appearing on 1st to 5th or the youngest leaf-sheaths.

The leaves of seedling were counted from the oldest to the youngest. Types 0 to 3 were regarded as resistant type reactions, types 4 and 5 were susceptible type reactions.

The sixteen differential varieties that served to differentiate physiologic races of *Piricularia oryzae* in our Department of Plant Pathology at Taiwan Agricultural Research Institute were also used to differentiate physiologic races of *Pellicularia sasakii* in the present experiment. They were selected by the empirical method, as given in the follows:

Variety	Type	Origin
Natala	Indica, upland	Taiwan
Cutsugulcul	Indica, upland	Taiwan
Taichung-ti-chio-wu-chien	Indica, lowland	Taiwan
Kao-chio-liu-chou	Indica, lowland	Taiwan
Kaohsiung-ta-li-chen-yu	Indica, lowland	Taiwan
Kung-shan-wu-shen-ken	Japonica, lolwand	Mainland China
Sencho	Japonica, lowland	Japan
Kanto 51	Japonica, lowland	Japan
Norin 21	Japonica, lowland	Japan

Chianung 280	Japonica, lowland	Taiwan
Chianung 242	Japonica, lowland	Taiwan
Kwang-fu 1	Japonica, lowland	Taiwan
Taichung 65	Japonica, lowland	Taiwan
Pai-kan-tao	Japonica, lowland	Taiwan
Taichung line 33	Japonica, lowland	Taiwan
Taichung 171	Japonica, lowland	Taiwan

Experimental Results

Cultural types — On potato sucrose medium, more than 300 isolates hitherto tested could be grouped into seven cultural types according to the rate of mycelial growth, coloration of substrate, days of sclerotial formation, number of sclerotia and other cultural characteristics of sclerotia. They are given in table 1.

Table 1. Cultural characteristics of 305 isolates on potato sucrose agar.

Cultural characteristics \ Cultural type	1	2	3	4	5	6	7
No. of isolates identified	41	54	49	44	18	32	67
Length of mycelia 24 hrs.	1.2	1.1	1.1	1.0	1.3	0.8	1.2
Length of mycelia 48 hrs.	4.4	4.0	4.4	3.6	4.7	3.8	5.0
Color of medium	—*	⧺	+	±	+	⧺	⧺
Aerial mycelium	fair	good	good	fair	fair	good	good
Days of white hyphal thread formation	3	4	3	4	4	6	3
Days of scl. formation	4	5	4	5	5	7	4
No. of scl.	21.5	9	6.5	aggregated	9	4.5	14.5
Size of scl. (cm) max.	0.16×0.06	0.17×0.09	0.16×0.03	—	0.14×0.05	0.13×0.05	0.12×0.04
Size of scl. (cm) min.	0.03×0.02	0.06×0.03	0.06×0.04	—	0.04×0.03	0.04×0.02	0.02×0.01
Shape of scl.	globose	irregular	irregular	—	elliptical	globose	globose
Color of scl.	sepia	cinnamon brown	dark brown	dark brown	purple brown	cinnamon brown	sepia
Places of scl. formation*** upper	—**	—	—	—	—	+	—
Places of scl. formation*** middle	+	+	+	+	+	+	+
Places of scl. formation*** base	+	+	+	+	+	+	+

*_ Not blackened, ± Slightly blackened, + Blackened, ⧺ Deeply blackened.
**_ No sclerotial formation, + With sclerotial formation.
*** In petri-dish.

Physiologic races — The reactions of 16 differential hosts to the seven representative isolates of *Pellicularia sasakii* (Shirai) Ito. are shown in table 2. Six physiologic races were recognized from the seven representative isolates which were grouped in accordance with their cultural characteristics. They are described as follows:

Race 1: This race brought about resistant reactions of the two upland

indica varieties and the seven locally developed *japonica* varieties except Chianung 280 and 242 varieties.

Race 2: The five *indica* varieties except the lowland variety Kaohsiung-ta-li-chen-yü were resistant to this race.

Race 3: This race incited resistant reactions of the three lowland *indica* varieties and susceptible reactions of the seven locally developed *japonica* varieties.

Race 4: This race produced susceptible reactions of the 11 lowland *japonica* varieties except the variety Chianung 280.

Race 5: The two upland *indica* varieties and the lowland *japonica* variety Kwang-fu 1 were resistant to this race, the rest gave susceptible reactions.

Race 6: This race revealed strong virulence to cause susceptible reactions of the sixteen differentials under the experimental condition.

Table 2. Reactions of sixteen differential varieties of rice to seven representative isolates of *Pellicularia sasakii.*

Differential variety \ Race	1	2	3	4	5	6
Representative isolate	15	43	28	30	11	8 & 50
Natala	−[a]	−	+[b]	−	−	+
Cutsugulcul	−	−	−	−	−	+
Taichung-ti-chio-wu-chien	+	−	−	−	+	+
Kao-chio-liu-chou	+	−	−	+	+	+
Kaohsiung-ta-li-chen-yu	−	+	−	+	+	+
Kung-shan-wu-shen-ken	+	+	−	+	+	+
Sencho	−	−	−	+	+	+
Kanto 51	+	+	−	+	+	+
Norin 21	+	+	+	+	+	+
Chianung 280	+	−	+	−	+	+
Chianung 242	+	−	+	+	+	+
Kwang-fu 1	−	−	+	+	−	+
Taichung 65	−	−	+	+	+	+
Pai-kan-tao	−	+	+	+	+	+
Taichung line 33	−	+	+	+	+	+
Taichung 171	−	+	+	+	+	+
Cultural type	3	6	4	5	2	1 & 7

a=reaction types 0 to 3.
b=reaction types 4 and 5.

Discussion and Conclusion

In the present study, more than 300 isolates of *Pellicularia sasakii* were grouped

into 7 distinct cultural types according to their cultural characteristics on potato sucrose agar. Of the seven cultural types, seven representative isolates, e.g. 8, 11, 15, 28, 30, 43, 50, were used for identifying the reaction isolates on the 16 differential varieties. Six physiologic races were differentiated. The numbers of sclerotia formed on potato sucrose agar seemed to be closely related to reactions of physiologic races on sixteen differential varieties of rice.

Matsumoto (1934) studied the physiology and parasitism of the fungus and grouped 16 strains of the fungus in Taiwan. Nakada and Kawamura (1939) identified 9 biotypes of the fungus according to the cultural characteristics on potato sucrose agar. It appeared, therefore, that the results of the present study comfirmed the existence of physiologic races of *P. sasakii* in Taiwan, characterized on the bases of their ability to attack rice varieties differentially and their cultural characteristics on potato sucrose agar.

Hashioka (1951) studying on the varietal resistant to *Corticium sasakii*, reported that the variety group of the Japanese lowland type was generally more liable to infection, whereas many of the tropical varieties, especially the native Taiwan, were rather resistant. Chiu (1962) tested rice varieties and lines against sheath blight in the uniform disease nurseries which were set up at four different localities on this island in 1961. He pointed out that Chin-Gou-Tsan and Taichung native No. 1 of the native types seemed to possess a high degree of resistance, whereas *japonica* varieties were more susceptible.

So far as the 16 differential varieties of rice used for identifying the reactions of the six physiologic races were concerned, the *indica* type varieties were more resistant than the *japonica* type varieties. Among the *indica* type, the upland varieties were more distinct than the lowland varieties.

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臺灣稻紋枯病菌生理小種之研究

簡 錦 忠　　鍾 順 昌

摘　　要

1. 自宜蘭、臺北、東勢、嘉義、屏東、臺東等地區，採集稻紋枯病害標本。經人工純系分離後，在馬鈴薯培養基上鑒別其培養型，並於溫室內擧行人工接種。所選用十六鑒別稻品種係本研究室供鑒定稻熱病菌生理小種所用者。

2. 305 個純系分離之稻紋枯病病原菌，在馬鈴薯培養基上，以其菌絲之生長，培養基之色澤，菌核之形成日期、數目、色澤、形狀及在培養皿內之位置等特性，可分爲七種培養型。

3. 根據以上七種培養型中，各選出一菌號，接種於選定之鑒別稻品種上，得到六種病原性不同之生理小種，即可分類爲 1，2，3，4，5 及 6 等小種。

4. 在十六鑒別稻品種上，在來稻之抗病性高於蓬萊稻。在來稻中，陸稻比水稻更顯著。

稻紋枯病菌菌核脫落之數量及其發芽試驗

簡 錦 忠　　鍾 順 昌　　朱 啓 魯

一、前　　言

1930年鑄方，人見氏[1]及1936年野津，橫木[2]氏等報告，越冬於土壤之稻紋枯病菌菌核經整地後浮游於水面上成爲第一次傳染源。1936年堀，來島，內野[3]氏等也報告整地直後浮游於水面之菌核最多，但中耕，除草等，作業亦能發現菌核之浮現與菌核之發芽力不因浮現時期之不同而有差異。1957年高坂氏等[4]試驗考察結果，菌核大部份於整地後浮現，其後一個月間隨時日逐漸減少，病原性亦有逐漸減弱之傾向。1958年木谷[5]氏等報告，於不同時期採集附着於稻株之菌核，比較其發芽力之結果，並無顯著差異。雖然本病菌於夜間能形成擔胞子，但其極纖弱，不能被認爲大發病之原因，所以稻紋枯病之第一次發生源，以越冬於土壤之菌核爲主，翌春經整地後浮游於水面，再附着葉鞘而感染[6]。

據鑄方[1]等調查稻收穫後，脫落於田間之菌核數量，每30平方公分內平均18個。叉野津[2]氏等調查被害嚴重之田間，每十公畝約20萬個以上之多，菌核與發病即有上述之關係，故本試驗於稻收割當天，調查平均被害度28.5%之稻田脫落菌核之數量，並以所採集之菌核供作室內發芽實驗，與人工培養之菌核作一比較。

二、菌核脫落於田間之數量調查

在臺北本所栽植臺中65號，經人工接種病原菌後，平均被害度28.5%之稻田，調查其菌核之數量，調查方法係1962年12月9日收割（稻株自地面上約15公分處收割）當天即行調查，任意選定30個點位，每一點位爲30平方公分撿算菌核數目，調查結果如表一：

表一：田間每一點位之菌核數

Table 1. Number of sclerotia observed on each spot in the paddy field.

調查點位 Spot investigated	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
菌核數 No. of sclerotia	60	121	129	117	41	52	48	73	26	37	105	38	50	34	54	67	104

調查單位 Spot investigated	18	19	20	21	22	23	24	25	26	27	28	29	30	總計 Tatal	平均 Average
菌核數 No. of sclerotia	51	39	38	37	60	36	32	36	73	35	45	39	51	1,728	57.5

據此次田間調查結果，每30平方公分內，自稻收割直後遺留於田間土表面之菌核最少26個，最多達129個之多，平均57.5個，由此數目估計每公頃約200萬個之菌核脫落於田間爲次期作之感染源。本調查係在稻被害程度28.5%之田間舉行，如果被害更嚴重之稻田可能菌核之脫落愈多，因此在防治上是值得吾人重視。

三、自然菌核與培養菌核之發芽試驗

據高坂[4]氏等報告：菌核之發芽溫度爲 20～30°C 最適溫度 28～30°C，其發芽濕度必須在95～96%以上。木谷[4]氏等認爲田間採集之自然菌核於水田水和肥料要素之溶解水面上，發芽率並

無差異。但水田水表面之菌絲生長顯著良好，且直射日光似乎不影響菌核之發芽。故本試驗係於培養皿、試管、燒杯等各種不同供試物質之溶解水面進行，放置於 28°C 定溫箱內，逐日調查發芽率。自然菌核係採自上次田間調查者，培養菌核與自然菌核同一菌系，經稻稈培養基一週所形成之菌核，放置於室內乾燥二週後供試之。

A. 菌核發芽與水質的關係

本試驗以試管內注入所需之水質，每試管放入三個菌核浮游於水面。雨水係當天下雨直接採集者，水田水，苗床土壤採自本所1963年一期作水稻苗床。另苗床土壤之試驗置於培養皿內，每培養皿內置 5 個菌核，菌核一半埋入土內，處理後置於28°C定溫箱內，每次試驗30個菌核，重覆三次。

表二：菌核發芽與水質的關係

Table 2. Showing the relation between the germination of sclerotia and water quality.

水質 Water quality	自然菌核 Natural sclerotia						培養菌核 Cultured sclerotia					
	24 hrs.		48 hrs.		72 hrs.		24 hrs.		48 hrs.		72 hrs.	
	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)
雨水 Rain water	24	0.5	76	1.0	85	1.4	100	1.2	100	1.6	100	1.8
自來水 Tap water	0	0	40	0.2	60	0.3	100	0.3	100	1.0	100	1.2
蒸餾水 Distilled water	0	0	40	0.2	50	0.3	68	0.2	100	0.3	100	0.8
水田水 Paddy field water	0	0	60	0.3	75	0.4	100	0.5	100	1.2	100	1.4
苗床土壤 Paddy field soil	0	0	0	0	0	0	100	0.4	100	0.9	100	1.6

結果，培養菌核重於自然菌核，試驗時均沈於水中發芽生長；自然菌核浮游於水面，菌絲在水面蔓延。一般言之，自然菌核之發芽力較差且在不同水質中之發芽率差異較大，以雨水中最好，但在苗床土壤中，經三天亦不發芽，其他三天內之發芽率有逐日增加之趨勢。培養之菌核在各水質中並無差異，24 小時內均能達 100% 之發芽率。以菌絲生長觀之，自然菌核及培養菌核均於雨水中最好，水田水次之。

B. 不同碳素源與菌核發芽之關係

水田水中溶解有各種不同之物質，木谷[5]氏等曾以肥料 3 要素之溶解水作試驗探知其間對菌核之發芽率並無差異。本試驗以 50 cc 燒杯注入 0.1% 之各種不同碳素溶液 10 cc，每燒杯放入菌核 10 個浮游於水面，對照處理使用蒸餾水以作比較。每次30個菌核，重覆兩次。

表三：不同碳素源與菌核發芽之關係

Table 3. Showing the relation between the germination of sclerotia and various carbon sources.

碳素源 Carbon source	自然菌核 Natural sclerotia						培養菌核 Cultured sclerotia					
	24 hrs.		48 hrs.		72 hrs.		24 hrs.		48 hrs.		72 hrs.	
	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)
Glucose	51	0.1	100	0.1	100	0.1	100	0.1	100	0.3	100	0.4

Galactose	100	0.1	100	0.6	100	0.9	100	0.1	100	0.7	100	1.8
Starch	—	—	70	0.2	70	0.2	40	0.1	100	0.2	100	0.3
Lactose	—	—	70	0.1	70	0.1	70	0.1	100	0.2	100	0.3
d Mannit	—	—	70	0.4	100	0.5	—	—	100	0.5	100	1.1
Raffinose	51	0.1	100	0.2	100	0.2	85	0.3	100	0.4	100	0.4
Dulcit	100	0.1	100	0.3	100	0.4	15	0.1	100	0.4	100	0.5
CK	—	—	50	0.4	85	0.4	—	—	100	0.5	100	0.5

在不同碳素源溶液中，一般培養菌核之發芽率均高於自然菌核，在24小時內各種不同碳素源對菌核發芽之影響似乎較大，48小時後調查時其差異即大爲減少，但比對照處理良好。自然菌核於24小時中在 Starch, Lactose, d Mannit 及對照處理均不發芽；48小時後各處理均能發芽，且發芽率高於對照處理。培養菌核於24小時中只 d Mannit 與對照處理不發芽；48小時後各處均達100%之發芽率。自然與培養菌核之菌絲生長都以 Galactose 及 d Mannit 最好。

C. 不同氮素源與菌核發芽之關係

處理方法與 B 項同

表四：不同氮素源與菌核發芽之關係

Table 4. Showing the relation between the germination of sclerotia and various nitrogen sources.

氮素源 Nitrogen source	自然菌核 Natural sclerotia						培養菌核 Cultured sclerotia					
	24 hrs.		48 hrs.		72 hrs.		24 hrs.		48 hrs.		72 hrs.	
	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)	發芽率 % of germ.	菌絲長 Leng. of myce. (cm)
$Ca(NO_3)_2$	—	—	50	0.2	100	0.4	100	0.3	100	0.8	100	1.4
$NaNO_3$	—	—	19	0.1	19	0.2	100	0.4	100	1.2	100	1.8
KNO_3	—	—	86	0.8	100	1.2	100	0.3	100	1.2	100	1.8
NH_4HPO_4	—	—	—	—	40	0.1	100	0.2	100	0.3	100	0.4
Asparagin	100	0.4	100	0.8	100	1.2	100	0.7	100	1.8	100	2.0
Glutamic acid	—	—	57	0.1	86	0.2	40	0.1	100	0.2	100	0.4
CK	—	—	50	0.4	85	0.4	—	—	100	0.5	100	0.5

24小時中，自然菌核在不同氮素溶液中除在 Asparagin 中發芽率達100%外其餘均不發芽，以後逐日增加，至第三天 $NaNO_3$ 及 NH_4HPO_4 比對照處理還差。菌絲生長以 Asparagin 及 KNO_3 最好。培養菌核之發芽率在24小時後均比對照處理爲優，不同氮素源溶液中似無差異。NH_4HPO_4 溶液中之自然菌核發芽率比蒸餾水之對照處理差，此與木谷氏[5]等所示硫安溶解水中之菌核發芽率低於其他井水，過磷酸石灰，鉀肥溶液者符合，據木谷氏解釋係試驗時濃度過高之原因。又據1953年池野，山田氏[7]等試驗結果，無鉀區及氮肥多量區之發病最多，以氮肥區內，如施用硫酸根肥料區比無硫酸根區之發病較多，根部之腐敗亦爲激烈。1961年陳其昌、簡錦忠、黃添福[8]等試驗結果，認爲施用氮肥量增加，被害率亦隨之增加，但稻之生育狀況如稻株高，穗數亦隨氮素之增加而旺盛，不過產量反而減少。因此土壤或灌溉水中之氮素源直接影響發病之可能性較少，以植物體內碳素源及氮素源直接促進已附着之菌核發芽及菌絲生長或直接影響植物體之抵抗性而增加發病之可能性較爲明顯。

D. 菌核對藥劑稀溶液之耐性

加入殺菌劑或由於藥劑撒佈使水田灌漑水呈藥劑稀溶液，以使浮游於水中之菌核致死，因而撲滅紋枯病之第一次傳染源是可能的。據1960年橋岡[9]氏等報告：自然菌核於有機汞劑及有機砷劑 3 ppm 溶液中經4天即失去致病力，但乃存纖弱之發芽菌絲；培養菌核於有機汞劑 5 ppm 中仍保持致病力。本試驗之處理方法與前項同，菌核置於數種殺菌劑稀溶液及 28°C 定溫箱，經4天後調查其發芽之情形。

供試藥劑種類及其成分如下：

A list of certain fungicides studied.

藥劑 Fungicide	有效成分 Active ingredients	形態 Form	製造廠 Manufacturer
Asozin	Methylarsin sulfide 5%	粉狀	日本庵原農藥公司
Neo Asozin	Ferric methylarsin ammonium 6.5%	溶液	日本庵原農藥公司
Mon Emul	Methylarsin bislauryl sulfide 16.5%	乳劑	日本北興化學工業公司
Urbazid	Methylarsin bisdimethyldithiocarbamate 80%	粉狀	西德 Bayer 公司
Blaes S_3	Blasticidin S 2%	粉狀	日本農藥公司
Granosan	Ethyl mercuric phosphate 5%	粉狀	美國 E. I. Du Pont de Nemours & Co.
Fumiron	Phenyl mercuric p-toluene sulfonanilide Ethyl mercuric phosphate Ethyl mercuric urea } 5%	片狀	日本北興化學工業公司

表五：菌核對藥劑稀溶液之耐性

Table 5. Tolerance of sclerotia to the dilute fungicidal solution.

藥劑 Eungicide	自然菌核 (%) Natural sclerotia			培養菌核 (%) Cultured sclerotia		
	6 ppm	3 ppm	1.5 ppm	6 ppm	3 ppm	1.5 ppm
Asozin	94	100	100	100	100	100
Neo Asozin	100	100	100	100	100	100
Mon Emul	100	100	100	100	100	100
Urbazid	100	100	100	100	100	100
Fumiron	86	86	100	86	86	100
Granosan	0	0	0	0	86	86
Blaes S_3	100	100	100	100	100	100
CK	100	100	100	100	100	100

如表五，自然菌核與培養菌核於藥劑稀溶液中，除 Granosan 外，其他並不受影響，Granosan溶液中，自然菌核於 1.5 ppm 即受抑制，培養菌核則 6 ppm 才能完全被抑制。藥劑種類中有機汞劑强於有機砷劑，但經藥劑處理所生長之菌絲其致病力之强度如何，尚待進一步作接種試驗。

E. 自然菌核之附着與發芽之關係

以上試驗進行中，發現自然菌核浮游於水面或附着於試管壁其發芽率似有差異，經用 50 cc 燒杯注入1% glucose 水溶液，每燒杯水面浮游5個菌核，水界管壁附着5個菌核，置於 28°C 定溫箱經48及96小時後調查50個菌核之發芽率如下：

表六：自然菌核之附着與發芽之關係

Tabld 6. Germination of natural sclerotia in relation to adhering to glass wall.

試驗次數 Repetition	水面 Water surface		管壁 Glass wall	
	48 hrs. (%)	96 hrs. (%)	48 hrs. (%)	96 hrs. (%)
1	28	100	100	100
2	27	100	100	100
Average	27.5	100	100	100

培養菌核重於自然菌核，在各處理中均沉於水中，發芽後菌絲於水中蔓延，發芽力都比自然菌核强，故本試驗之結果並無差異。

表六顯示，經48小時後水面上之發芽率僅及附着菌核之三分之一，但96小時後竟達100%，可知浮游於水面之菌核發芽力比附着菌核慢，據野津[2]等報告認爲乾田比濕田之初發病率高，此可能由於越冬菌核數多，附着稻株之菌核數增加，或濕田中菌核隨灌溉水流出圃場外之機會多之故。木谷[10]氏亦認爲株莖數多之稻叢，菌核附着機會多，發病期早，發病率亦有增高之傾向，所以紋枯病之發生與菌核之附着有密切關係，同時菌核之附着亦能影響菌核發芽及發病之遲早，高坂[11]氏1959年作水之動搖與菌核發芽之試驗推定菌核在動搖之水面或漂流狀態中很不易發芽。如果在灌溉不良之水田，菌核在靜止之水面上發芽與附着稻叢發芽之菌絲，其致病力有無差異，尚待研究與觀察。

四、摘　　要

1. 本報告係調查稻紋枯病第一次發生有關之越冬菌核，脫落於田間之數量及比較田間採集之自然菌核與室內人工培養菌核之發芽力。

2. 菌核於割稻時，大部份脫落於田間，被害程度在28.5%之稻田，約每公頃有200萬個之菌核脫落，爲次期作之第一次傳染源，越冬於土壤之菌核可能由於整地，中耕，除草等作業浮游於水面後附着葉鞘而感染。

3. 一般培養菌核之發芽力比自然菌核强，培養菌核於1天內卽能達100%之發芽率，自然菌核則需3天以上。

4. 水質與菌核之發芽，似無顯著差異，但對菌絲生長以雨水最優，水田水次之。自然菌核於苗床土壤上經三天未見發芽。

5. 不同碳素源及氮素源與菌核發芽之關係，自然菌核之發芽在不同碳素源中均比蒸餾水之對照處理爲佳，但氮素源中 NH_4HPO_4 及 $NaNo_3$ 却比對照差。

6. 藥劑稀釋溶液對菌核發芽之抑制作用，有機汞劑强於有機砷劑，Granosan 1.5 ppm 卽能抑制自然菌核之發芽，培養菌核需達 6 ppm 才具抑制效果。

7. 浮游於水面之菌核，其發芽力比附着菌核差。所以發病與菌核之附着，菌核附着與發芽均有密切關係。

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STUDIES ON THE NUMBER OF SCLEROTIA OF RICE SHEATH BLIGHT FUNGUS DROPPED ON THE PADDY FIELD AND DIFFERENCE OF GERMINABILITY BETWEEN NATURAL AND CULTURED ONES

by

C. C. CHIEN, S. C. JONG and C. L. CHU

Summary

1. The present paper deals with an estimation of the number of sclerotia spontaneously dropped on the paddy field and difference in germination rate between natural and artificially cultured sclerotia in relation to water quality, nutrients and fungicidal chemicals.

2. In 28.5% diseased paddy field, approximately two millions of sclerotia per hectare were estimated to be dropped on the soil surface. The dropped sclerotia may serve as the primary inocula in the successive crop-season adhering on leaf-sheath through irrigation water.

3. In general, the germinability of cultured sclerotia was stronger than that of natural ones. The rate of germination in cultured ones reached to 100% within one day, while that of natural ones needed more than three days.

4. No distinct difference in effect of sclerotial germination for different kinds of water was found. However, rainwater was found to give more effect the growth of mycelia than the paddy field water. No germination of sclerotia was observed within three days after the drop of sclerotia on the surface of paddy soil.

5. It was found that various carbon sources gave good effect to sclerotia germination as compared to distilled water, while NH_4HPO_4 and $NaNo_3$ solutions of nitrogen source gave bad effect.

6. The diluted fungicidal solution of organomercurials were found to give stronger inhibitory effect to sclerotia germination than organoarsenicals. Granosan which belong to the former could inhibit the germination of natural sclerotia at 1.5 ppm concentration, however it needed 6 ppm concentration for artificially cultured ones.

7. As stated before the germinability of sclerotia adhered on leaf-sheath was stronger than those of floating on water surface. From this fact it is known that there are close relation among outbreak of the disease and germination and adhere of sclerotia.

BIOASSAY OF CERTAIN FUNGICIDES FOR THE RICE BLAST FUNGUS, *PIRICULARIA ORYZAE*(1)

by

S. C. Jong, C. C. Chien and C. L. Chu

Blast disease due to *P. oryzae* is widely distributed in rice growing countries, particularly in Taiwan, and is considered as the most important rice disease, accordingly the studies on this disease have been made from various angles in major rice-growing countries. In connexion with its control, application of fungicides is now generally considered as one of the important cultural practices and also largely put into practice in many countries. In Taiwan, fungicides now recommended for controlling the disease are mercury compounds. Granosan used for seed treatment; Ceresan-lime or Fumiron tablet used for controlling the leaf and neck blast in the field. Mercury compounds recently used may cause leaf injury on *Indica* type of rice, although at present it is almost satisfactorily controlled by applying with organic mercury compounds mentioned above.

In the present paper, certain resultant data of the laboratory experiments on evaluation of the fungicidal action of the certain commercial fungicides recently recommended for controlling the rice diseases in Japan against rice blast fungus are reported.

Materials and Methods

Fungicides studied and method of assay: The following fungicides were tested.

Commercial name	Active ingredients	Manufacturer
Fumiron Tablet	Phenyl mercuric p-toluene sulfonanilide, Ethyl mercuric phosphate, Ethyl mercuric urea } 5%	Japan
Takeda Mer Tablet	Phenyl mercuric dinaphthyl methane disulfonate 4.08%	Japan
Simmer Tablet	Phenyl mercuric acetate 5.6% Phenyl mercuric chloride 1.6% Phenyl mercuric dinaphthyl methane disulfonate 0.8%	Japan
Mergon Powder	Ethyl mercuric p-toluene sulfonanilide 7.92%	Japan

(1) The authors wish to acknowledge their indebtedness to Dr. Lung-chi Wu of the National Taiwan University for a reading of the Manuscript.

Blaes M Powder	Blasticidin 1% Phenyl mercuric acetate 1.66%	Japan
Blaes S_3 Powder	Blasticidin 2%	Japan
Dithane 31 Powder	Maneb (manganese ethylene bisdithiocarbamate) 53.0%	U.S.A
Mei-ko-nung Emul.	Phenyl mercuric acetate 5%	Taiwan

These fungicides were diluted with dist. water at the different concentrations of the active ingredient. Bioassay was conducted by means of the method in vitro (dipping and fumigating of spore and hyphae), in semivivo (infection on cut sheath in a petri-dish with Takahashi's sheath cell inoculation test) and in vivo (inoculation with potted seedling plants). In the Petri-dish experiments, the sheath (8 cm in length) were dipped in the fungicidal solutions for a moment and placed in a moistened large petri-dish (15 cm in diameter) after disiccation of the coated fungicide. In the pot experiments, however, the test plant was sprayed with the fungicidal solutions or suspensions of the definite quantity.

The fungus employed and method of inoculation: the fungus which was supplied by the laboratory of physiological specilization of rice blast fungus in our institute and designated as 0S-45S isolate (P group, 13 race), was employed throughout the present experiment. It was cultured sucessively on the yeast starch agar plate at 28°C. Spores were harvested from the 10-day culture by agitation with distilled water and glass beads and used for germination test and inoculation. A round piece of hyphal thread was cut from the 14-day-culture by use of a cork borer and used for drag tolerance test. In the petri-dish experiment, inoculation was conducted by means of Takahashi's sheath cell inoculation test. In the pot experiments, the seedlings at 3–5 leaves stage were inoculated by spraying with spore suspension which contain 10^6 spores per ml under a specially designed greenhouse with controlled moisture and temperature.

Experimental results

A. Drag tolerance of spore germination

1. Inhibition to spore germination by direct dipping:

The fungus was cultured in a yeast starch agar slant for 10 days. Then 10 ml of the fungicidal solution at 100 p.p.m. was poured into the slant so as to make the spore suspension at the concentration of 1×10^6/ml. The spore dipping in the fungicidal solutions or suspensions was tested on slide glass in a moistened Petri-dish at 28°C. After 24 hours, the germinability of thus spore was inspected.

Table 1. Tolerance of spore of the rice blast fungus to the different fungicidal solutions or suspensions at 100 p. p. m.

Fungicde \ Item	No. of spore examined	No. of germinated spore	rate of germination	index number (CK 100)
Fumiron	1,085	16	1.47	1.49
Takeda Mer	645	16	2.48	2.52
Simmer	1,367	18	1.32	1.34
Blaes S_3	344	31	9.01	9.16
Blaes M	339	12	3.54	3.60
Mergon	695	4	0.58	0.58
Dithane 31	905	614	67.85	68.99
Mei-ko-nung	908	7	0.77	0.78
CK	545	536	98.35	100.00

As shown by table 1, under the adequate condition of temperature and moisture, 98 per cent spores of the fungus germinated within 24 hours after incubation. All of the fungicides exerted the inhibitory effect on spore germination. Among the fungicides tested, Mergon and Mei-ko-nung showed to be the most effective and the Dithane 31 did not show so much effect.

2. Inhibition to spore germination by gas:

The spore obtained from a yeast starch agar slant which was cultured for 10 days was tested on slide glass in a Petri-dish which was moistened with filter paper containing fungicidal solution or suspension at 100 p. p. m. 24 hours after incubation, the effectiveness of gas inhibition to spore germination was read with counting the number of germinated spores.

Table 2. Tolerance of spore of the rice blast fungus to the gases of different fungicidal solutions or suspensions at 100 p. p. m.

Fungicide \ Item	No. of spores examined	No. of germinated spore	rate of germination	index No. (CK 100)
Fumiron	433	229	52.80	58.00
Takeda Mer	549	413	75.23	83.64
Simmer	550	366	66.55	73.99
Blaes S_3	629	596	94.75	105.33
Blaes M	751	441	58.72	65.23
Mergon	859	12	1.40	1.56
Dithane 31	739	648	87.68	97.48
Mei-ko-nung	640	31	4.84	5.38
CK	368	331	89.95	100.00

According to Table 2, among the fungicides tested, Mergon and Mei-ko-nung showed to be the most effective as same as in the previous experiment. However Fumiron, Takeda Mer, Simmer and Blaes M, showed so less effective and Blacs S_3, Dithane 31 were ineffective.

So far as the results were concerned, Mergon and Mei-ko-nung were much more efficacious in both direct dipping and gas fumigating on the inhibitory effect of spore germination.

B. Drag tolerance of hyphae

1. Inhibition to hyphal growth by direct dipping:

According to Hashioka (1961), the fungus was cultured in a Petri-dish for 2 weeks. Then 50 ml of the fungicidal solution or suspension at 100 p. p. m. was poured into the dish so as to make the hyphal thread soak in the solution or suspension for 10, 20, 30, and 60 min., respectively. After appropriate time of immersion, the hyphal thread was cut with cork borer at the size of 7 mm in diameter, and wash twice with dist. water. 8 days after incubation, the viability of thus-treated hyphal piece was read by means of transferring it onto the agar plate.

Table 3. Tolerance of hyphae of the rice blast fungus to the different fungicidal solutions at 100 p. p. m.

Fungicide	Time of dipping (min)			
	10	20	30	60
Fumiron	++*	+	−	−
Takeda Mer	+	+	−	−
Simmer	+	+	−	−
Blaes S_3	+++	+++	+++	+++
Blaes M	++	+	−	−
Mergon	−	−	−	−
Dithane 31	+++	+++	+++	+++
Mei-ko-nung	++	+	−	−
CK	++++	+++	+++	+++

*Number of − + marks indicates the grade of mycelial development.

As shown by table 3, at 100 p. p. m. the hyphae are killed by brief dipping in Mergon whereas Fumiron, Takeda Mer, Simmer, Blaes M and Mei-ko-nung require 30 min to kill hyphae. While the suspensions of Blaes S_3 and of Dithane 31 are not lethal to hyphae within 60 min.

2. Inhibition to hyphal growth by gas:

The round piece of hyphal thread from 2-week-culture was cut by use of a cork-borer and transferred on the potato sucrose agar plate. Then the inoculated Petri-dish was reversed and the filter paper containing fungicides was put on the inner of the cover so to fumigate the agar plate. It was inspected two days interval after incubation.

As shown by table 4, the fungicides tested except Blaes S_3 and Dithane 31 could comparatively prevent the hyphal growth in the early stage of incubation. Afterward the hyphal growth started because the gas of fungicide gradually de-

Table 4. Toleance of hyphae of the rice blast fungus to the gases of different fungicidal solutions or suspensions at 100 p. p. m.

Fungicide	Days after inoculation			
	4	6	7	8
Fumiron	1 mm*	2 mm	4 mm	6 mm
Takeda Mer	—	—	2	3
Simmer	—	—	—	—
Blaes S_3	11	15	20	25
Blaes M	2	3	5	7
Mergon	—	—	—	—
Dithane 31	10	12	18	22
Mei-ko-nung	—	—	0.5	0.5–1
CK	11	15	20	25

*Length of mycelia.

creased. On 8th day, when the filter paper impregnated with fungicides became dry the fungicides were entirely ineffective. It is clear from the resultant data the hyphae are completely killed by the gases of Simmer and Mergon. Such a tendency is roughly killed by the gases of Simmer and Mergon. Such a tendency is roughly coincide with that in the experiment of spore germination test stated above.

C. Experiments with the cut sheath

The sheaths of a lowland rice variety, Taichung 65, at heading stage were cut and dipped in different fungicidal solutions or suspensions at 50 and 100 p. p. m. for a moment. After desiccation of the coated solutions or suspensions, those sheaths were inoculated and incubated by means of Takahashi's (1958) sheath cell inoculation test. Spore tested was obtained from a yeast starch agar tube which was cultured for 10 days.

Table 5. Preventive action of the different fungicidal solutions or suspensions at 50 and 100 p. p. m., to the rice infection.

Concentration / Fungicide	50 ppm			100 ppm		
	Germination	Appresorium	Infection	Germination	Appresorium	Infection
Fumiron	—	—	—	—	—	—
Takeda Mer	—	—	—	—	—	—
Simmer	+	+	+	—	—	—
Blaes S_3	+	+	+	+	+	+
Blaes M	—	—	—	—	—	—
Mergon	—	—	—	—	—	—
Dithane 31	+	+	+	+	+	+
Mei-ko-nung	—	—	—	—	—	—
CK	+	+	+	+	+	+

No germination, appresorium formation and infection were observed under microscopic test on the inner surface of cut sheath treated by Fumiron, Takeda Mer, Blaes M, Mergon and Mei-ko-nung at 50 p. p. m.. However Simmer at 50 p. p. m., Blaes S_3 and Dithane 31 at 100 p. p. m. the spore germination, formation of appresorium and infection were as well as that of control. From the result mentioned above, it is clearly recognized that the preventive action, in semi-vivo was roughly coincide with that in the experiment of spore germination. If the fungicide can exert the inhibitory effect to spore germination, it may be concerned possessing efficacy for preventive action to blast infection on rice.

D. Experiments with the potted plant

The susceptible variety of Taichung 65 to the blast fungus of isolate 0S-45S was grown in fungus free soil in iron flat (30cm×30cm in size) and top-dressed twice each with 50 ml of 2% ammonium sulfate solution. The seedlings at 3-5 leaves stage were inoculated by spraying spore suspension which contain 10^6 spores per ml. under a specially designed green house with controlled moisture and temperature. In the experiments concerning the preventive effect, the seedlings were atomized by the solution or suspension of the respective fungicide at 100 p. p. m. 5 hours prior to inoculation, whereas in those of therapeutic effect they were sprayed 24 hours after inoculated plants were kept in an inoculation chamber in which the moisture (90-05%) and temperature (25-28°C) were controlled. About 24 hours after inoculation the flats were returned to the green house. Four or five days later, the inoculated seedling was examined and the type of infection read according to Abumiya's scale proposed in 1955.

Table 6. Effects of preventive and therapeutic spraying of the different fungicides on the blast infection on the seedling rice at 100 p. p. m.

Fungicide	Preventive spraying		Therapeutic spraying	
	Infection [a]	Phytotoxicity [b]	Infection [a]	Phytotoxicity [b]
Fumiron	−	−	+	−
Takeda Mer	−	+	+	+
Simmer	+	+	+	++
Blaes S_3	+	+	++	+
Blaes M	−	++	−	++
Mergon	−	−	−	−
Dithane 31	++	−	++	−
Mei-ko-nung	−	−	−	−
CK	++	−	++	−

a −mark shows no infection. +mark shows resistant type. ++mark shows susceptible type.
b +marks shows the grade of phytotoxicity.

Considering the effects of preventive and therapeutic action of various fungicides

hitherto tested on the blast infection of the seedling rice, it is evident that the preventive action of organomercurials except Simmer is more distinct than that of nonorganomercurials. But in the therapeutic application, the Fumiron and Takeda Mer of organomercurials did not show so much effect. Although the gas or suspension of Simmer tested in vitro showed more or less effective to the hyphal growth and spore germination of blast fungus. As to phytotoxicity of each fungicides to the seedling rice tested, Simmer and Blaes M brought about more serious injury appearing brown spot on the leaves and sheaths of the seedling sprayed. Takeda Mer and Blaes S_3 also appeared a little injury.

Discussion and Conclusion

In general, the effectiveness of various fungicides against plant pathogens in field practice are varied with kinds of diseases. For example, Phenyl Mercuric Acetate against rice blast fungus in paddy field is more effective than that of rice sheath spot fungus, but the Urbazid is reverse (Inoue 1958; Hashioka 1961; Chen 1959; Chien 1962). However, a given fungicide possesses its special fungitoxicity against a certain pathogen in field. Sometimes in the field trials, we could detect the phenomenon that effectiveness of a certain fungicide in preventive action against a given plant disease differed with that in therapeutic application.

So far as the fungicides employed throughout the present experiments were concerned, the inhibitory effect on both preventive and therapeutic action was merely detected in those, Mergon, Mei-ko-nung and Blaes M. All of them were of organomercurials. Although Fumiron in vitro and semi-vivo gave distinct fungicidal action, nevertheless in vivo for therapeutic spraying, it did not show so much effect. Simmer in vitro both direct and gas inhibition showed considerable effect on spore germination and hyphal growth, while in semi-vivo and vivo, inoculation was made after desiccation of the coated suspension so that efficacy of Simmer under this condition having almost evaporated, its fungitoxicity diminished immediately before inoculation.

From the result stated above, it is evident that vapor action of certain organomercurials tested in laboratory against blast fungus repressed the spore germination and hyphal growtn rather distinctly. And then, we can draw the conclusion that the difference of effectiveness of those fungicides hitherto tested under the experimental conditions, is considered to be possible due to the differences of durability and vapor action on the foliage. Such phenomenon are coincide with the experiments made by Hashioka on bioassay of the organic fungicidal substances for the rice sheath spot fungus in 1961.

Summary

1. In the present paper, certain resultant data of the laboratory experiments on evaluation of the fungicidal action of the certain commercial fungicides recently

recommended for controlling the rice diseases in Japan against rice blast fungus are reported.

2. Fungitoxicity of the fungicides hitheto tested under the experimental condition for controlling the rice blast fungus, is considered possibly due to the differences of durability and vapor action of them on the foliage.

3. It was proved in vitro that the organomercurials were distinctly efficacious than nonorganomercurials.

4. So far as the experiments in vitro and in vivo were concerned, Mergon and Mei-ko-nung seemed could be determined as the practical fungicides. The efficacy of Mergon and Mei-ko-nung could cover that of the Fumiron recently recommended for controlling the rice blast in Taiwan.

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幾種殺菌劑對稻熱病菌之防治效力檢定

鍾順昌　簡錦忠　朱啓魯

摘　　要

本試驗爲檢定 Fumiron 片劑，Takeda Mer 片劑，Simmer 片劑，Mergon 可濕性粉劑，Blaes M 可濕性粉劑，Blaes S_3 可濕性粉劑，Dithane 31 可濕性粉劑及 Mei-ko-nung (美谷濃) 乳劑等稻作病害常用之殺菌劑，對稻熱病菌之防治效力而舉行。於 vitro, semi-vivo 及 vivo 試驗中，由於實驗條件之不同，各藥劑之效果略有差異。但有機汞劑之效力均比非有機汞劑爲佳，其中 Mergon 可濕性粉劑及 Mei-ko-nung (美谷濃) 乳劑之防治與治療效果都比標準藥劑 Fumiron 片劑較顯著。其藥效之高低，似與藥劑之持續效果及蒸氣壓之差異，具有密切關係。

幾種種子消毒劑對稻熱病及稻苗徒長病病原菌之消毒試驗

朱啓魯 簡錦忠 鍾順昌

一、緒 言

以往本省之稻種子消毒藥劑，多用 Uspulun (烏斯普龍)，惟因該劑操作上較爲複雜且其效果亦不甚理想，自民國四十年起改用 Granosan (谷樂生)，實施以來對於防除稻熱病 (Piricularia oryzae Cav.) 及稻苗徒長病 (Gibberella fujikuroi (Saw.) Wr.) 之效果甚佳。近來農用藥劑之製造，發展甚速，新出品之種子消毒劑相繼問世，作者等特就數種新藥劑擧行試驗，以比較其與原來所用者之殺菌效果。

藥劑殺菌力之分析比較方面，Horsfall (1956) 首先倡導 ED_{50} 法，其意爲制止菌類發育達 50% 時之有效藥劑量，本試驗即引用此法，ED_{50} 法可用直線方程式繪成直線，以表明藥劑之效力及藥劑之濃度與制菌力之相互關係，由藥量反應曲線可立即判別殺菌力之程度，若某種殺菌劑之 ED_{50} 需要量大時，即表示其藥效差，反之則顯示該藥劑之殺菌能力强，亦即藥劑愈有效時，則 DR curve (藥量反應曲線) 愈狹陡，反之，藥效愈差時，則 DR curve 愈平坦。本試驗係於實驗室內施行，進一步之資料有待於田間之試驗。

本文稿惠蒙農復會羅宗爵技正賜閱並校正，特申謹誌謝忱。

二、試驗材料及方法

1. 試驗材料：

A 供試病原菌爲稻熱病病原菌(Piricularia oryzae Cav.)及稻苗徒長病病原菌 (Gibberella fujikuroi (Saw.) Wr.)。

B 供試藥劑計六種，各殺菌劑之名稱及主要成分如表一。

表一 供試殺菌劑之名稱及主要成分

Table 1. Kinds of seed disinfestants tested and their ingredients.

藥劑名稱 Fungicides	製造公司 Manufactory	有效成分 Active ingredients	形狀 Form
Granosan	U. S. A.	5% Ethyl mercury phosphate	Powder
Takeda Mer	Takeda K. K. Japan	3.85% phenyl mercuric dinaphthyl-methane disulfonate (Hg 1.54%)	1.3gr tablet
Nichinou Mer	Nippon Noyaku K. K. Japan	3.3% phenyl mercuric dinaphthyl-methane disulfonate (Hg 1.3%)	1.5gr tablet
Riogen	Sunkyo K. K. Japan	2.5 Ethyl mercuric chloride, 1.0 Phenyl mercuric acetate	1.0gr tablet
Ruberon	Hokko K. K. Japan	3.45% Ethyl mercuric phosphate (Hg 2.5%)	1.0gr tablet
Uspulun	Nippon Tokushu Noyaku K. K. Japan	4.2% Methoxy ethyl mercuric chloride (Hg 2.5%)	2.0gr tablet

2. 試驗方法：

A. 病原菌之培養：以臺中65號穀粒加2%之蔗糖水溶液浸漬一小時，然後取出分裝於250 cc之三角瓶中，每瓶裝100 gr，經高壓殺菌後，以事先培養二週之病原菌作成胞子懸浮液，每瓶注入10 cc，俟菌絲長滿後供作試驗之用。

B. 處理方法：各殺菌劑之供試濃度配成 mg/L（每 1,000 cc 蒸餾水中含有效成分若干 mg 之 Hg 量）及ppm 等單位。將長滿菌絲之水稻種子浸漬於各種殺菌劑之稀釋液中，浸漬時分爲10分，30分，60分及120分鐘，浸漬後將藥液傾出，以無菌水充分洗滌，再移置於馬鈴薯培養基上（每培養皿注入培養基 15 cc），每皿內置15～20粒種子，然後放入28°C之定溫箱內，經一定期間後，觀察各處理區之消毒效果。

本試驗於民國51年3月至12月間重複舉行共八次。每次處理後經3～6天觀察其藥效，各種供試藥劑加水稀釋後之最後濃度如表二。

表二 各種殺菌劑試驗時所採用之濃度

Table 2. Concentrations of the fungicides tested

藥劑名稱 Fungicide	稀釋倍數 Dilution	最後濃度 Final conc. mgHg/L	備註
Granosan	1,000	35.0 mg/1,000 cc	各種殺菌劑之稀釋濃度，係按各殺菌劑說明書之使用濃度稀釋之。tab./L 表示 1,000 cc 蒸餾水中所用之藥劑片數。
Takeda Mer	2.0 tab./L	39.0 mg/1,000 cc	
Ruberon	1.3 tab./L	22.5 mg/1.000 cc	
Uspulun	1.5 tab./L	75.0 mg/1,000 cc	
Riogen	1.7 tab./L	40.8 mg/1,000 cc	
Nichinou Mer	1.0 tab./L	19.5 mg/1,000 cc	

三、結果及討論

表三 供試藥劑對防除稻熱病及稻苗徒長病病原菌之效果

Table 3. Effectiveness of fungicides against *P. oryzae* and *G. fujikuroi*

藥劑名稱 Fungicide	處理時間 Duration of treatment (min.)	稻熱病菌 *P. oryzae* 防除效果 Percentage of control (%)	稻熱病菌 *P. oryzae* 順序 Rank	稻苗徒長病菌 *G. fujikuroi* 防除效果 Percentage of control (%)	稻苗徒長病菌 *G. fujikuroi* 順序 Rank
Granosan	10	93.50	2	96.68	3
	30	100.00		100.00	
	60	100.00		100.00	
Takeda Mer	10	3.50	5	39.35	5
	30	56.00		71.75	
	60	86.25		82.50	
Ruberon	10	91.75	3	99.18	1
	30	100.00		100.00	
	60	100.00		100.00	
Uspulun	10	18.50	4	12.00	6
	30	81.00		62.50	
	60	90.00		98.55	

Riogen	10 30 60	100.00 100.00 100.00	1	99.05 100.00 100.00	2
Nichinou Mer	10 30 60	0.00 12.50 58.98	6	68.35 91.05 96.65	4
CK	10 30 60	0.00 0.00 0.00	7	0.00 0.00 0.00	7

由表三可知，Nichinou Mer 對 G. fujikuroi 之抑制效果較 P. oryzae 略爲良好，其他殺菌劑對二病菌間之抑制效果，差異不大。Riogen 處理 10 分鐘對 P. oryzae 可完全抑制其發育，但對 G. fujikuroi 稍差，而需 30 分鐘始能完全抑制。Granosan 及 Ruberon 處理30分鐘可抑制兩種病菌之發育。Takeda Mer，Uspulun 及 Nichinou Mer 處理60分鐘仍不能完全抑制該兩種病菌之發育，此三種殺菌劑究竟是供試濃度過低抑或處理時間過短，須待今後再行檢討。

供試六種殺菌劑中，Granosan 係目前本省推廣稻種消毒所供用之藥劑，因此該劑作爲標準藥劑時，其他殺菌劑之消毒效果與 Granosan 之效果略同者僅爲 Riogen 及 Ruberon 兩種，其餘如按各藥劑所附說明書上之濃度使用時，便不能抑制 P. oryzae 或 G. fujikuroi 之發育。

爲適應生物曲線之分析起見，各種種子消毒劑之濃度採用 40，20，10，5 ppm，其結果如下：

由表四 a 及圖一顯示 Granosan 效果最佳，Ruberon，Riogen 次之，Uspulun 效果最差。Takeda Mer 之 ED_{50} 約爲 10 ppm，Nichinou 之 ED_{50} 約爲 18 ppm。

表四 b 及圖二仍顯示 Granosan 效果最佳，Ruberon，Riogen 次之，藥效最差者爲 Uspulun，其 ED_{50} 約 42 ppm。

表四 c 及圖三指出 Ruberon 及 Granosan 之交切點在 20 ppm，即濃度在 20 ppm 以上時，Ruberon 之藥效優於 Granosan，低於 20 ppm 時，則 Granosan 之藥效較 Ruberon 爲佳，藥效最差者仍爲 Uspulun。當濃度爲 5 ppm 時，其制菌效果均在 50 以上。

由表五 a 及圖四可知 Riogen 之 ED_{50} 約爲 15 ppm，Nichinou Mer 之 ED_{50} 約爲 24 ppm。

表五 b 及圖五表明 Riogen 之 ED_{50} 約爲 10 ppm，Nichinou Mer 之 ED_{50} 約爲 18 ppm，Uspulun 之 ED_{50} 約爲 38 ppm。

六種藥劑中，Riogen 在抑制稻熱病病原菌時列爲第三位，而用以抑制稻苗徒長病原菌時則降至第四位，而次於 Takeda Mer。Takeda Mer 抑制稻苗徒長病病原菌較抑制稻熱病病原菌有效。有些藥劑在 DR curve 線上雖顯示效果良好，但 F 值小於 F 0.05 者，則表示其差異不顯著，所以應降低其濃度以求其 ED_{50} 所需之劑量。

表四：供試藥劑之不同濃度對稻熱病病原菌之種子消毒效果

Table 4. Different fungicides against *P. oryzae* under various times

a 浸漬30分鐘之效果

藥劑名稱	重複	40 ppm 防除效果（%）	20 ppm 防除效果（%）	10 ppm 防除效果（%）	5 ppm 防除效果（%）	CK 防除效果（%）	回歸線 Regression line
Granosan	1	100.00	100.00	93.34	73.36	0.00	$y=0.34x+98.18$
	2	100.00	100.00	93.34	80.02	0.00	F value=2.93
	3	100.00	100.00	86.68	60.04	0.00	$2.93<F0.05=4.67$
Takeda Mer	1	100.00	93.34	60.04	60.04	0.00	$y=1.14x+38.64$
	2	100.00	80.02	66.70	60.04	0.00	F value=5.936
	3	100.00	73.36	53.38	46.72	0.00	$5.936>F0.05=4.67$
Ruberon	1	100.00	100.00	86.68	53.38	0.00	$y=0.47x+84.56$
	2	100.00	100.00	80.02	60.04	0.00	F value=3.386
	3	100.00	100.00	80.02	46.72	0.00	$3.386<F0.05=4.67$
Uspulun	1	33.40	0.00	0.00	0.00	0.00	$y=0.28x+3.7$
	2	6.76	0.00	0.00	0.00	0.00	F value=0.911
	3	20.08	0.00	0.00	0.00	0.00	$0.911<F0.05=4.67$
Riogen	1	100.00	80.02	27.34	6.76	0.00	$y=0.88x+70.73$
	2	100.00	80.02	33.40	6.76	0.00	F value=13.71
	3	100.00	66.70	46.72	13.42	0.00	$13.71>F0.05=4.67$
Nichinou Mer	1	100.00	27.34	0.00	13.42	0.00	$y=1.52x+28.76$
	2	100.00	6.76	33.40	0.00	0.00	F value=56.711
	3	100.00	40.06	20.08	13.42	0.00	$56.711>F0.05=4.67$

註：處理期間溫度 28°C

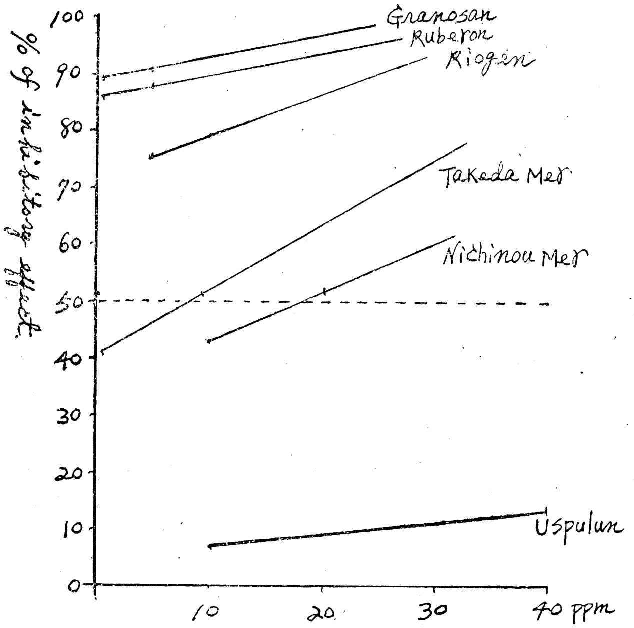


Fig. 1. DR curves of different Fungicides against *P. oryzae* for 30 min.

b 浸漬60分鐘之結果

藥劑名稱	重複	40 ppm 防除效果（%）	20 ppm 防除効果（%）	10 ppm 防除效果（%）	5 ppm 防除效果（%）	CK 防除效果（%）	回歸線 Regression line
Granosan	1	100.00	100.00	100.00	80.02	0.00	$y=0.13x+95.34$
	2	100.00	100.00	86.68	100.00	0.00	F value=1.927
	3	100.00	100.00	93.34	86.68	0.00	1.927<F0.05=4.67
Takeda Mer	1	100.00	93.34	60.04	80.02	0.00	$y=1.25x+46.31$
	2	100.00	80.02	73.36	66.72	0.00	F value=9.662
	3	93.34	93.34	80.68	53.38	0.00	9.662>F0.05=4.67
Ruberon	1	100.00	100.00	93.34	66.70	0.00	$y=0.28x+90.86$
	2	100.00	100.00	86.68	73.36	0.00	F value=2.944
	3	100.00	100.00	86.68	53.38	0.00	2.944<F0.05=4.67
Uspulun	1	33.40	20.08	0.00	0.00	0.00	$y=1.48x-9.31$
	2	33.40	13.42	0.00	0.00	0.00	F value=96.72
	3	27.34	27.34	0.00	0.00	0.00	96.72>F0.05=4.67
Riogen	1	100.00	86.68	80.02	46.72	0.00	$y=0.51x+81.55$
	2	100.00	93.34	60.04	60.04	0.00	F value=6.377
	3	100.00	86.68	53.38	60.04	0.00	6.377>F0.05=4.67
Nichinou Mer	1	100.00	60.04	20.08	13.42	0.00	$y=0.72x+66.38$
	2	100.00	73.36	20.08	20.08	0.00	F value=16.055
	3	100.00	80.02	27.34	13.42	0.00	16.055>F0.05=4.67

註：處理期間溫度 28°C

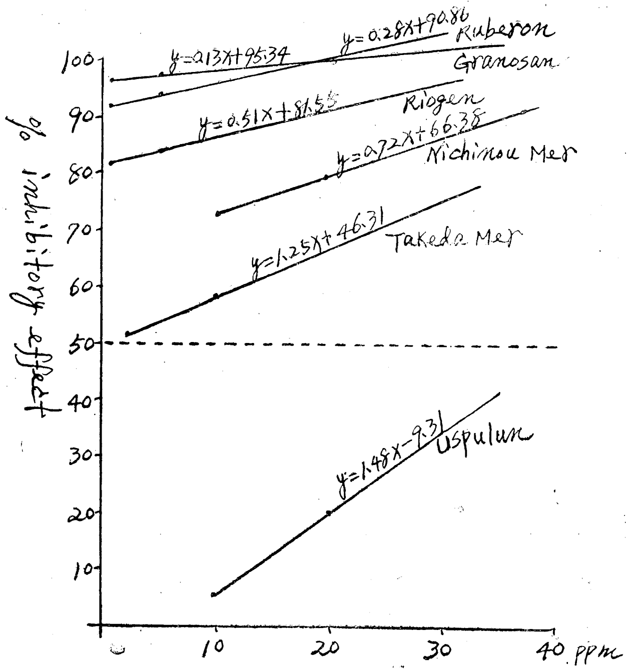


Fig. 2. DR curves of different fungicides against *P. oryzae* for 60 min.

c 浸漬 120 分鐘之結果

藥劑名稱	重複	40 ppm 防除效果(%)	20 ppm 防除效果(%)	10 ppm 防除效果(%)	5 ppm 防除效果(%)	CK 防除效果(%)	回歸線 Regression line
Granosan	1	100.00	100.00	100.00	86.68	0.00	$y=0.02x+99.34$
	2	100.00	100.00	93.34	93.34	0.00	F value=0.489
	3	100.00	100.00	100.00	100.00	0.00	$0.489<F0.05=4.67$
Takeda Mer	1	100.00	93.34	73.36	73.36	0.00	$y=0.97x+62.38$
	2	100.00	86.68	80.02	60.04	0.00	F value=16.274
	3	100.00	93.34	80.02	86.68	0.00	$16.274>F0.05=4.67$
Ruberon	1	100.00	100.00	86.68	80.02	0.00	$y=0.12x+96.08$
	2	100.00	100.00	93.34	66.72	0.00	F value=0.182
	3	100.00	100.00	100.00	80.02	0.00	$0.182<F0.05=4.67$
Uspulun	1	46.72	6.76	0.00	0.00	0.00	$y=0.73x+58.95$
	2	40.06	27.34	0.00	0.00	0.00	F value=8.65
	3	60.06	40.06	0.00	0.00	0.00	$8.65>F0.05=4.67$
Riogen	1	100.00	93.34	93.34	86.68	0.00	$y=0.21x+93.28$
	2	100.00	93.34	93.34	66.70	0.00	F value=2.482
	3	100.00	93.34	80.02	73.36	0.00	$2.482<F0.05=4.67$
Nichinou Mer	1	100.00	100.00	73.36	40.06	0.00	$y=0.38x+81.22$
	2	100.00	93.34	73.36	46.72	0.00	F value=5.731
	3	100.00	86.68	80.02	46.72	0.00	$5.731>F0.05=4.67$

註：處理期間溫度 28°C

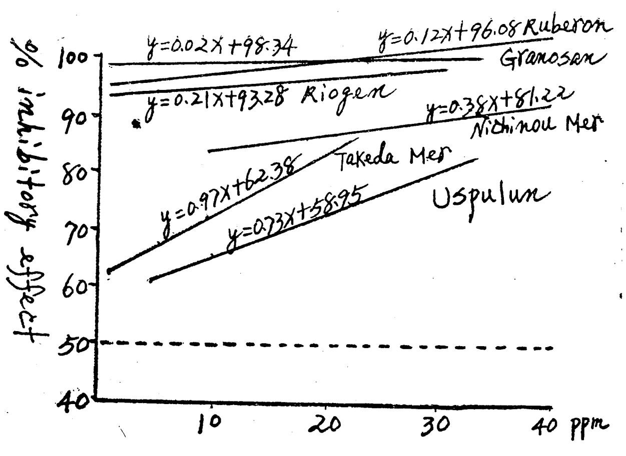


Fig. 3. DR curves of different fungicides against *P. oryzae* for 120 min.

表五　供試藥劑之不同濃度對稻苗徒長病病原菌之種子消毒效果

Table 5. Different fungicides against *G. fujikuroi* under various times

a　浸漬30分鐘之結果

藥劑名稱	重複	40 ppm 防除效果 (%)	20 ppm 防除效果 (%)	10 ppm 防除效果 (%)	5 ppm 防除效果 (%)	CK 防除效果 (%)	回歸線 Regression line
Granosan	1	100.00	100.00	100.00	93.34	0.00	$y=1.23x+67.5$
	2	100.00	100.00	100.00	86.68	0.00	F value=9.39
	3	100.00	100.00	100.00	66.70	0.00	$9.39>F0.05=4.67$
Takeda Mer	1	80.02	60.04	66.74	60.96	0.00	$y=1.30x+50.09$
	2	100.00	96.68	27.34	60.96	0.00	F value=62.99
	3	73.36	27.34	53.38	13.42	0.00	$62.99>F0.05=4.63$
Ruberon	1	100.00	100.00	100.00	100.00	0.00	$y=1.12x+62.9$
	2	100.00	100.00	100.00	73.36	0.00	F value=12.71
	3	100.00	100.00	86.68	60.04	0.00	$12.71>F0.05=4.67$
Uspulun	1	40.06	0.00	0.00	0.00	0.00	$y=0.59x-6.04$
	2	27.34	0.00	0.00	0.00	0.00	F value=4.138
	3	40.06	0.00	0.00	0.00	0.00	$4.138<F0.05=4.67$
Riogen	1	100.00	100.00	100.00	60.04	0.00	$y=2.52x+7.84$
	2	100.00	100.00	73.36	80.02	0.00	F value=69.49
	3	100.00	100.00	86.68	46.72	0.00	$69.49>F0.05=4.67$
Nichinou Mer	1	86.68	66.70	46.72	33.40	0.00	$y=2.61x-11.06$
	2	80.02	73.36	60.04	20.08	0.00	F value=62.99
	3	86.68	66.70	46.72	20.08	0.00	$62.99>F0.05=4.67$

註：處理期間溫度 28°C

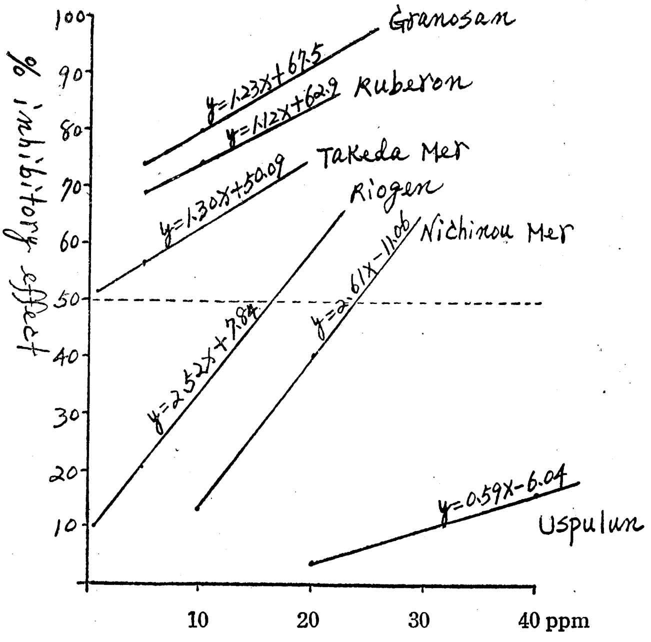


Fig. 4. DR curves of different fungicides against *G. fujikuroi* for 30 min.

b 浸漬60分鐘之結果

藥劑名稱	重複	40 ppm 防除效果(%)	20 ppm 防除效果(%)	10 ppm 防除效果(%)	5 ppm 防除效果(%)	CK 防除效果(%)	回歸線 Regression line
Granosan	1	100.00	100.00	100.00	100.00	0.00	$y=0.29x+90.11$
	2	100.00	100.00	100.00	93.34	0.00	F value=4.93
	3	100.00	100.00	100.00	80.02	0.00	$4.93>F0.05=4.67$
Takeda Mer	1	100.00	86.68	86.68	60.04	0.00	$y=0.87x+65.37$
	2	96.68	40.06	60.04	66.70	0.00	F value=7.701
	3	93.34	80.02	46.72	20.08	0.00	$7.701>F0.05=4.67$
Ruberon	1	100.00	100.00	100.00	100.00	0.00	$y=1.27x+64.53$
	2	100.00	100.00	93.34	86.68	0.00	F value=10.69
	3	100.00	100.00	100.00	73.36	0.00	$10.69>F0.05=4.67$
Uspulun	1	40.06	6.76	0.00	0.00	0.00	$y=1.78x-20.46$
	2	60.04	27.34	6.76	0.00	0.00	F value=192.42
	3	53.38	20.08	6.76	0.00	0.00	$192.42>F0.05=4.67$
Riogen	1	100.00	100.00	100.00	73.36	0.00	$y=3.61x+9.55$
	2	100.00	100.00	100.00	53.38	0.00	F value=49.417
	3	100.00	100.00	100.00	66.70	0.00	$49.417>F0.05=4.67$
Nichinou Mer	1	93.34	93.34	80.02	73.36	0.00	$y=2.5x+5.44$
	2	86.68	73.36	73.36	66.70	0.00	F value=103.63
	3	100.00	80.02	80.02	53.38	0.00	$103.63>F0.05=4.67$

註：處理期間溫度 28°C

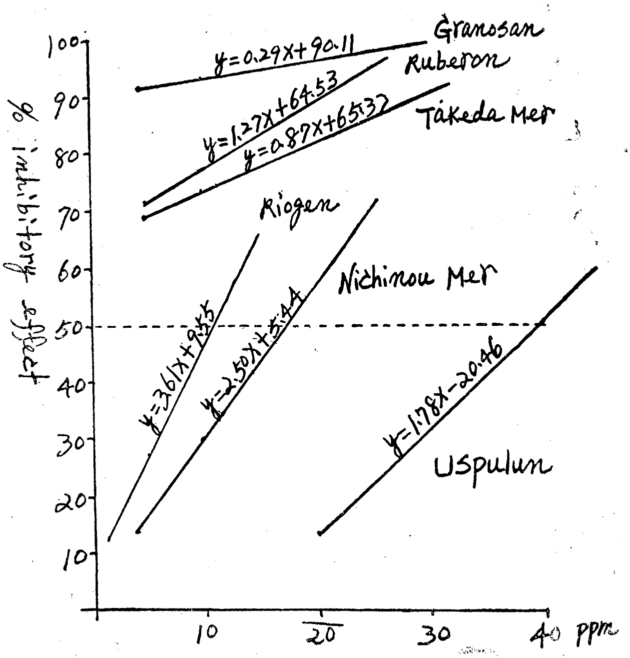


Fig. 5. DR curves of different fungicides against *G. fujikuroi* for 60 min.

c　浸漬 120 分鐘之結果

藥 劑 名 稱	重 複	40 ppm 防除效果 (%)	20 ppm 防除效果 (%)	10 ppm 防除效果 (%)	5 ppm 防除效果 (%)	CK 防除效果 (%)	回 歸 線 Regression line
Granosan	1	100.00	100.00	100.00	100.00	0.00	$y=0.15x+94.96$
	2	100.00	100.00	100.00	100.00	0.00	F value=15.31
	3	100.00	100.00	100.00	96.68	0.00	$15.31>F0.05=4.67$
Takeda Mer	1	93.34	86.68	66.70	80.02	0.00	$y=0.76x+71.32$
	2	100.00	93.34	73.36	47.72	0.00	F value=25.17
	3	100.00	86.68	86.68	53.38	0.00	$25.17>F0.05=4.67$
Ruberon	1	100.00	100.00	100.00	86.68	0.00	$y=0.95x+74.41$
	2	100.00	100.00	100.00	93.34	0.00	F value=8.553
	3	100.00	100.00	100.00	100.00	0.00	$8.553>F0.05=4.67$
Uspulun	1	66.70	53.38	46.72	33.40	0.00	$y=1.48x-9.33$
	2	46.72	60.04	46.72	13.42	0.00	F value=50.716
	3	60.04	53.38	53.38	27.34	0.00	$50.716>F0.05=4.67$
Riogen	1	100.00	100.00	100.00	80.02	0.00	$y=0.59x+78.39$
	2	100.00	100.00	100.00	86.68	0.00	F value=24.352
	3	100.00	100.00	100.00	100.00	0.00	$24.352>F0.05=4.67$
Nichinou Med	1	93.34	93.34	100.00	86.68	0.00	$y=1.34x+53.23$
	2	93.34	80.02	86.68	80.02	0.00	F value=2.34
	3	100.00	100.00	73.36	73.36	0.00	$2.34<F0.05=4.67$

註：處理期間溫度 28°C

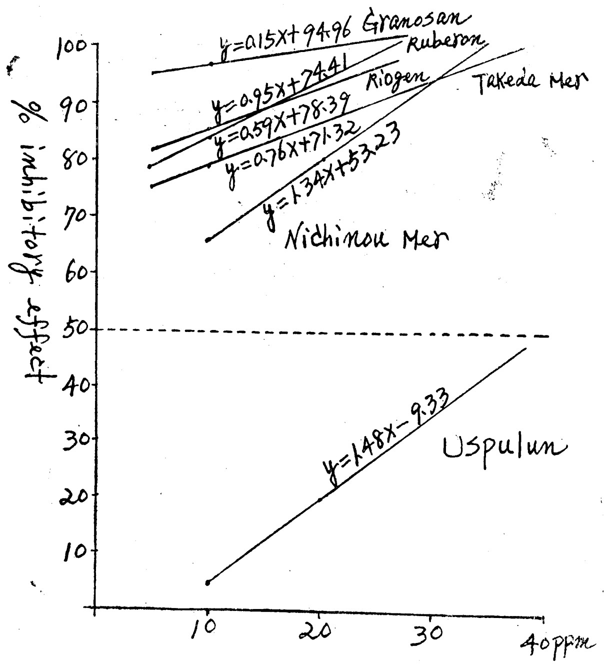


Fig. 6.　DR curves of different fungicides against *F. fujikuroi* for 120 min.

四、摘　　要

本試驗目的在探求經濟而有效之種子消毒藥劑，供試之病原菌有兩種，即稻熱病菌及稻苗徒長病菌，本試驗所得結果如下：

1. 種子消毒劑對稻熱病病原菌之消毒所採用之濃度，分別爲 1.8 tab./L，1,000 倍，1.3 tab./L，1.5 tab./L， 2.0 tab./L，1.0 tab./L 時（依照各種殺菌劑說明書之使用濃度），其抑制病菌之次序爲 Riogen，Granosan，Ruberon，Uspulun，Takeda Mer，Nichinou Mer。

a. Riogen 之濃度爲 1.8 tab./L (40.8 mgHg/L) 時，浸種十分鐘即可完全抑制稻熱病菌絲之發育。

b. Granosan 之濃度爲 1,000 倍 (5 mgHg/L) 時，浸種三十分鐘即可完全抑制稻熱病菌絲之發育。

c. Nichinou Mer 之濃度爲 1 tab./L (19.5 mgHg/L) 時，浸種一小時有 58.97% 之抑制效果，浸種十分鐘時則毫無效果。

2. 種子消毒劑對稻苗徒長病病原菌所採用之濃度，分別爲 1.3 tab./L，1.8 tab./L，1,000 倍，1 tab./L，2 tab./L，1.5 tab./L 時（依照各種殺菌劑說明書之使用濃度），其抑制病原菌之次序爲 Ruberon，Riogen，Granosan，Nichinou Mer，Takeda Mer，Uspulun。

a. Ruberon 之濃度爲 1.3 tab./L (22.5 mgHg/L) 時，浸種十分鐘可完全抑制稻苗徒長病菌絲之發育。

b. Riogen 之濃度爲 1.8 tab./L (40.8 mgHg/L) 時，浸種三十分鐘可完全抑制稻苗徒長病菌絲之發育。

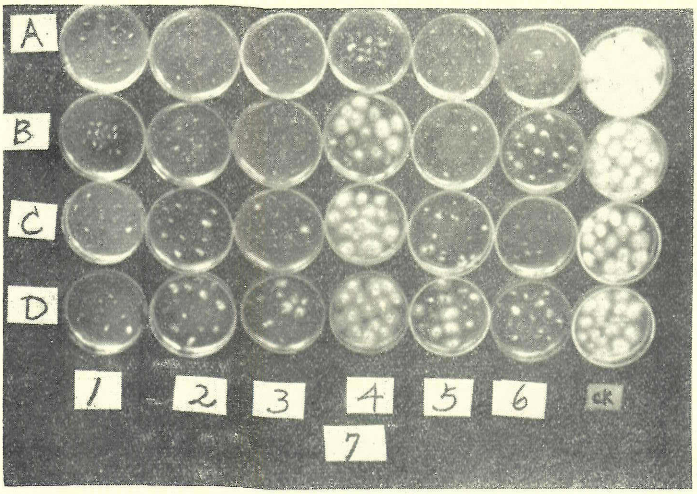
3. 藥劑對稻熱病菌消毒 60 分鐘時，Granosan 最有效，藥效最差者爲 Uspulun。Takeda Mer 之 ED_{50} 約爲 10 ppm，Nichinou Mer 之 ED_{50} 約爲 18 ppm。

4. 藥劑對稻苗徒長病處理 30 分鐘時，Granosan 藥效最佳，藥效最差者爲 Uspulum，Riogen 之 ED_{50} 約爲 15 ppm，Nichinou Mer 之 ED_{50} 約爲 24 ppm。

5. 藥劑對稻苗徒長病菌處理 60 分鐘時，Granosan 最有效，Uspulun 藥效最差，Riogen 之 ED_{50} 約爲 10 ppm，Nichinou Mer 之 ED_{50} 約爲 18 ppm，Uspulun 之 ED_{50} 約爲 38 ppm。

6. 此項結果，均係在實驗室內試驗者，其實用價值仍須舉行田間試驗證明之。

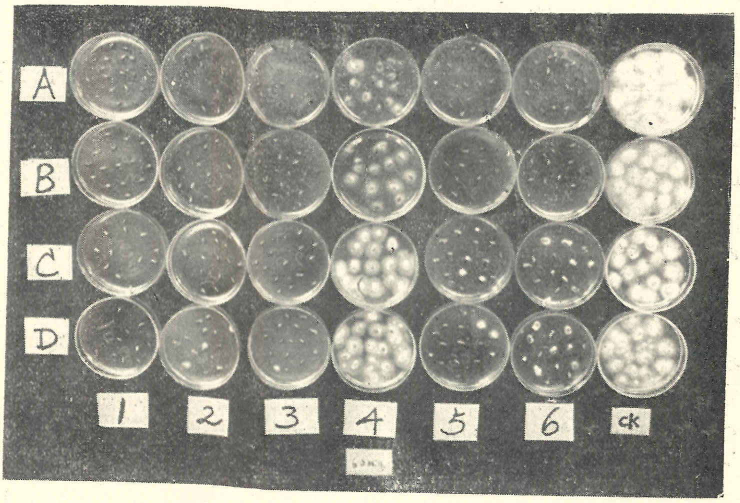
五、圖　　片



A＝40 ppm
B＝20 ppm
C＝10 ppm
D＝ 5 ppm
1＝Granosan
2＝Takeda Mer tablet
3＝Ruberon tablet
4＝Uspulun tablet
5＝Riogen tablet
6＝Nichinou Mer tablet
7＝30 minutes

不同濃度之幾種種子消毒劑處理三十分鐘對稻苗徒長病抑制菌絲發育之狀況

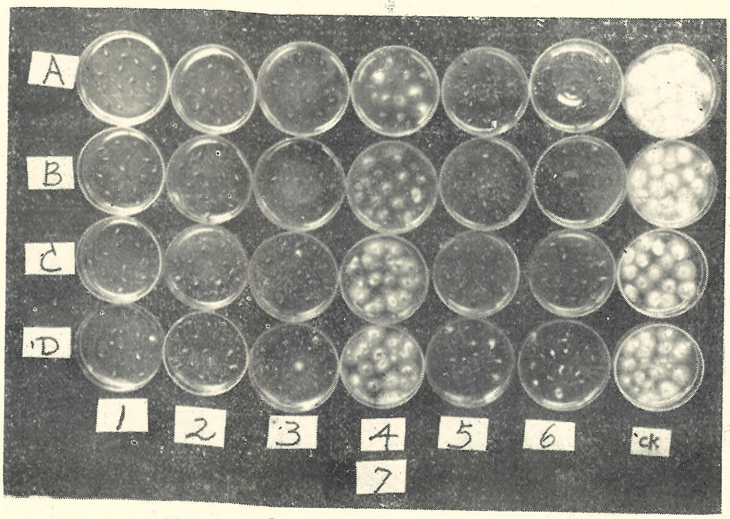
Effects showing different concentrations of fungicides used for rice seed treatment for 30 minutes against *G. fujikuroi*



A＝40 ppm
B＝20 ppm
C＝10 ppm
D＝ 5 ppm
1＝Granosan
2＝Takeda Mer tablet
3＝Ruberon tablet
4＝Uspulun tablet
5＝Riogen tablet
6＝Nichinou Mer tablet
7＝60 minutes

不同濃度之幾種種子消毒劑處理六十分鐘對稻苗徒長病抑制菌絲發育之狀況

Effects showing different concentrations of fungicides used for rice seed treatment for 60 minutes against *G. fujikuroi*



A＝40 ppm
B＝20 ppm
C＝10 ppm
D＝ 5 ppm
1＝Granosan
2＝Takeda Mer tablet
3＝Ruberon tablet
4＝Uspulun tablet
5＝Riogen tablet
6＝Nichinou Mer tablet
7＝120 minutes

不同濃度之幾種種子消毒劑處理二小時對稻苗徒長病抑制菌絲發育之狀況

Effects showing different concentrations of fungicides used for rice seed treatment for 120 minutes against *G. fujikuroi*

六、參 考 文 献

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TESTING ON FUNGICIDES FOR RICE SEED TREATMENT FOR CONTROLLING *PIRICULARIA ORYZAE* CAV. AND *GIBBERELLA FUJIKUROI* (SAW.) WR.

by

C. L. CHU, C. C. CHIEN and S. C. JONG

Summary

Blast (*Piricularia oryzae* Cav.) and Bakanae disease (*Gibberella fujikuroi* (Saw.) Wr.) are two important seed borne diseases on paddy rice. Since the past decade, treatment of rice seeds with mercuric compounds has been adopted by the farmers to control the diseases. Granosan is used more popularly in this island. In order to find some fungicides more economic and effective than Granosan, several mercuric compounds with their trade names as Takeda Mer, Ruberon, Riogen, Nichinou Mer etc., were tested in the laboratory.

Results obtained are summarized as follows:

1. Comparative testing of the fungicides was carried out in accordance with Horsfall's method, measurement of ED_{50} was made and DR curves were presented in this report.

2. Under the concentrations recommended by the manufactories, effectiveness of the testing fungicides against *P. oryzae* is arranged in a descending order, namely; Riogen tablet (1.8 tab./L), Granosan wp (1: 1,000) Ruberon tablet (1.3 tab./L), Uspulun (1.5 tab./L). Takeda Mer tablet (2 tab./L), Nichinou Mer tablet (1 tab./L).

3. With the same concentration as mentioned above, the effectiveness of the fungicide against *G. fujikuroi* is arranged in a descending order namely: Ruberon tablet (1.3 tab./L), Riogen tablet (1.8 tab./L), Granosan wp (1: 1,000), Nichinou Mer tablet (1 tab./L), Takeda Mer tablet (2 tab./L), Uspulun tablet (1.5 tab./L).

4. Under the concentrations of 5, 10, 20, 40 ppm respectively, the compounds tested to *P. oryzae* and *G. fujikuroi*, Granosan wp. is the most effective chemical, while Uspulun tablet was less effect.

The results to be adopted for practice should be checked by field testing.

BLACK PARLATORIA, *PARLATORIA ZIZYPHUS* (LUCAS)

by

LIANG-CHUAN CHANG & CHIA-CHU TAO

The common black citrus-infesting Parlatoria is the most injurious citrus pest of Taiwan because the scales tightly cover the leaves, fruits or twigs. The infested fruits even after brushing through waxing machine or with fingers, the scales still stick on the peel, therefore, the infested fruits are rejected for export to the market. Moreover, the insect takes seven generations a year, the dead scales accumulated and occupied nearly all over the surface of infested area (fig. 7 & 8) due to the covered area, the photosynthesis was interrupted and the twigs die very quickly.

The scale is very flat and stick firmly on the host, the natural enemies are very difficult to attack and so the chemical control. Before drafting the manuscript, 1% summer oil plus 0.05% malathion or 0.05% parathion is the only method to control it and this method was well accepted by the growers in Taiwan.

Morphology, life history, natural enemies and chemical control of this species have been briefly studied and summarized in below. The writers wish to express their sincere thanks to Dr. T. W. Liu, Head of Plant Industry Division of Joint Commission on Rural Reconstruction and Dr. S. G. Hsu, Director of Taiwan Agricultural Research Institute for their encouragement in this study.

I. Description of *Parlatoria zizyphus* (Lucas)

Common names: The Mediterranean scale, black chaff scale, the common black citrus infesting Parlatoria.

Hosts: Many species and varieties of *Citrus*.

Distribution: Tropical and subtropical countries of the following area: (See accompanying Fig. 1.)

Asia: Burma, Caucasus, Ceylon, Indo-China, Java, Philippine, Siam, South China mainland, South Japan, Straits Settlement, Sumatra.

Pacific Ocean: Hawaii, New Zealand.

Northern Africa: Algeria, Egypt, Morocco.

Southern Europe: France, Greece, Italy, Malta, Portugal, Sicily, Spain.

America: British Guiana, Cuba, Dominica, Haiti.

Egg: Shiny purple, elliptical, arranged under the posterior end of mother scale, the eggs are usually seen including crawlers under the scale at the same time. Egg stage takes 2 days in summer and 4–5 days in winter.

Nymph: Crawler comes out from underneath the scale, takes a short walk for searching suitable place such as leaf, twig or fruit then settles down and secretes

waxy substance to enclose the body posteriorly. The secretion enlarges and thickenes gradually to form scale. The first exuvia is black with longitudinal and transversal carinae. The secretion is pushed out terminally and surrounded. Body of the post stage of second instar of the female is flat and broad, covered with broad secretion membrane. The head of the post stage of second instar of the male has two brownish purple eyes which are visible from above, whenever, the body gradually changes to reddish purple.

Adult: Male: After passing second moult, the ecdysis is quite different from the female, it changes to prepupa. The second exuvia does not add to the scale, therefore, the scale just leaves one exuvia which is black and egg shaped. Then the body gradually changes to reddish purple.

Female: Second exuvia large, rounded rectagular, occupied the large part of the scale, which is black, there are 2–3 longitudinal carinae. After gravidity, the posterier body becomes swollen and darkened. Just moulting of second exuvia of third instar, there is a secretion membrame which covers around the scale, and breaks in the old adult. However, the caudal membrane is large and visible, this is the difference between stages of the old and young. After oviposition, the body shrinks and dies.

Dr Mc Kenzie illustrated the female body very completely and copied in below.

"Dorsal submarginal macroducts relatively few, ranging from 10–14. Dorsal intermediate macroducts lacking. Microducts situated as indicated in the accompanying Fig. 2. Three pairs of well developed pygidial lobes, practically equal in size, faintly once-notched on either side. Fourth lobes resembling sclerotized spur. Fifth lobes apparently lacking. Plates between median lobes slender, these between third lobes and just beyond fourth lobes broadened, apically fimbriate. Intermediate plate between third and fourth lobes widest; remaining plates narrow, irregularly lanceolate and apically fimbriate. Anal opening situated about mid-pygidium, vulva slightly above this. Perivulvar pores in four distinct groups, anterior laterals with usually 5 or 6 pores, posterior laterals with usually 10 pores. Prosoma membranous with 3 to 7 small, inconspicuous ventral duct tubercles along body margin between anterior and posterior spiracles, 7 to 9 along margin opposite posterior spiracle and 4 to 6 on margin of first abdominal segment. Eyespot greatly enlarged, appearing as ear-like lobes on the anterior margin of the prosoma. Anterior spiracle with 2 to 4 adjacent multilocular disk pores. Derm pocket between posterior spiracle and body margin lacking. Body 0.6- mm. long and 0.60 mm. wide."

The prominent ear-like eyespot on the anterior lateral prosomal margin and the blackish scale readily separate this species from all other related species.

Duration of different stages of female in April to June of 1957 was observed by Mr. S. L. Chang as follow: Egg 3 days, first stadium 7 days, second stadium 16 days, third stadium 13 days total 39 days. Male egg 3 days, first stadium 7 days, second stadium 16 days, prepupa 3 days, pupa 4 days, total 33 days respectively.

Life history

Life cycle of year round from June of 1956 to June of 1957 was shown in the following table.

Table I: Life Cycle of Black Parlatoria in 1956–1957, Taipei, Taiwan.

Number of generation	Duration of						
	egg	Ist instar	2nd. instar	3rd. instar	oviposition period	one generation	Months Occupied
4	2	6	13	11	7	42	June-Aug .
5	2	6	14	11	8	45	Aug-Sept.
6	3	8	19	16	12	62	Sept-Nov.
7	3	13	30	24	18	93	Oct-Jan.
1	4	9	18	15	15	65	Jan.-March
2	4	8	16	13	10	55	March-May
3	3	7	16	13	8	51	April-June

II. Comparision of related species infesting on the same host

Other than *Parlatoria zizyphus* (Lucas) there are another two species infesting on the same host, namely *Parlatoria pergandii* Comstock and *Parlatoria proteus* (Curtis). They may be separated by the following key:

A. Scale of adult female black ....*zizyphus* (Lucas)

AA. Scale of adult female whitish or grey, circular or oval ....B.

B. Pygidium with 3 pairs of lobes, the fourth lobe replaced by a fringed plate ....*proteus* (Curtes)

Parlatoria proteus (Curtis), Common name: Proteus or Sanseveria scale; Synonym: *Aspidiotus proteus* Curtis, *Diaspis parlatoris* Targioni-Tozzetti, *Parlatoria orbicularis* Targioni-Tozzetti, *Aspidiotus targionii* del Guercio, *Parlatoria* (*Euparlatoria*) *proteus* (Curtis), *Syngenaspis proteus* (Curtis). Adult female scale elongate oval, slightly convex, very thin and delicate, semitransparent, second exuvia quite large, general color yellowish-brown. Male scale elongate, white, exuvia yellowish brown.

BB. Pygidium with 4 pairs of lobes ....*pergandii* Comstock

Parlatoria pergandii Comstock, Common name: chaff scale, Synonym: *Parlatoria sinensis* Maskell. Adult female scale oval, whitish, gray or little brown, the exuvia darker not usually enlarged. Male scale elongate oval and the same color as that of adult female.

III. Natutal enemies

There are two groups of natural enemies, one is parasitic wasps and another is parasitic fungi. 4 Species of the parasitic wasps have been recorded, namely *Aphytis chrysomphali* (Mercet), *A. proclia* (Walker), *Aspidiotiphagus citrinus* Craw and *A. lounsburyi* (Berlege and Paoli), all of them belonging to Aphelinidae. Due to the

scale so flately and tightly covering the whole body, it is not favourable for the parasites, the percentage of parasitism is very low. according to examination of 186,870 scals, 3314 individuals only 1.07% were parasited. The morphology of each species may be outlined as below.

1. *Aphytis chrysomphali* (Mercet) (Fig. 3), Common name: golden chalcid, Synonym: *Aphelinus chrysomphali* Mercet, *Aphelinus quaylei* Rust, *Aphelinus mytilaspidis* Le Baron. Other hosts in Taiwan: *Chrysomphalus aonidum* (Linne), *Lepidosaphes gloveri* Packard and *Aonidiella aurantii* Maskell. Distribution: Spain, California, South Africa, Southen Rhodesia, Letaba Estates, Transvasl, China mainland, Japan.

Adult: Pale lemon yellow to pallid, including setae on the head, thorax, and abdomen. Integument very soft. Mesosternum with a pronounced black line down the middle; posterior margin of the scutellum narrowly black (The small sclerites at the bases of the front wings are dusky or blackish in all species). Mandible brown. Front wings with a faint dark cloud beneath the stigma and a more distinct cloud more or less across the disc beneath the union of the marginal and submarginal veins. Front wings most often with five rows of hairs basad of the speculum. Longest marginal fringe of the front wings ranging from one-fourth to one-fifth of the greatest width of the disc. Mesoscutum generally with 10 setae, rarely with either 8 or 12 setae. Propodeum with small, weak, separate crenulae. Pupae pale yellow or pallid, without any dark markings, with some possible exceptions. Males without microscopic stippling on the venter of thorax. Males exceedingly rare.

2. *Aphytis proclia* (Walker) (Fig. 4), Common name: golden chalcid. Synonym: *Aphelinus proclia* Walker, *Aphelinus diaspidis* Howard, *Aphelinus fuscipennis* Howard, Other hosts in Taiwan; *Parlatoria pergandii* Comstock, *Aonidiella aurantii* Maskel. Distribution: South Africa, South China, Florida, California.

Adult: Antennal club three times as long as wide, flagellum uniformly dark, but the club not blackish at the apex; mesoscutum and scutellum completely brownish, or nearly so, except for a pale longitudinal stripe down the middle; mesoscutum on the average, with 16 setae; abdomen with dark spots and coarse setae on the sides, and sometimes with weak dark bands across the dorsum; front wings with a distinct cloud beneath the stigma and the union of the submarginal fringe about one-sixth as long as the greatest width of the disc.

These two *Aphytis* have the same generic characters as the adult has an oblique hairless streak transversely from the stigma to the posterior margin of the front wings; a fusion of the dorsal remnant of the ninth tergum to the tenth tergum to form a syntergum at the apex of the abdomen; the restricted ovipositer seemingly lying in a grove, with the basal part enclosed by the sterna and the apical part exposed; the antennae 6-segmented; the body not conspicuously mottled; the wings generally without hyaline spots or bands of transparent hairs in combination with fuscous spots or bands of dark hairs; the body and legs not usually long and

slender.

3. *Aspidiotiphagus citrinus* (Craw) (Fig. 5), Common name: yellow scale parasite. Synonym: *Coccophagus citrinus* Craw, *Encarsia citrinus* Riley and Howard, *Aspidiotiphagus citrinus* Howard, *Prospaltoides howardi* Bréthes, *Aspidiotiphagus schoeversi* Smits van Burgst. Other hosts in Taiwan: *Aspidiotus destructor* Signoret, *Lepidosaphes becki* Newman, *Lepidosaphes gloveri* Packard, *Parlatoria pergandii* Comstock. Distribution: Europe, Africa, Australia.

Adult: Submarginal vein with two small setae. First funicle joint not the shortest, the funicle and club plainly usually differentiate. the longest marginal fringe of the fore wings are longer than the greatest width of the blade.

4. *Aspidiotiphagus lounsburgi* (Berlese and Paoli) (Fig. 6), Common name: yellow scale parasite. Synonym: *Prospaltella lounsburgi* Berles and Paoli. Other hosts in Taiwan: *Chrysomphalus aonidum* Linne. Distribution: Europe, Africa, Australia.

Adult: Occipt, checks, lower part of face, pronotum, axillae, sides of thorax, abdomen except the sixth and seventh tergites are definitely dark brown to blackish; remainder of the head and thorax are yellow. Scape and apical club joints faintly dusky. Legs faintly suffused with fuscous in parts, the darker coloration rather too indefinite to describe in detail. Submarginal vein with one small seta. Fore wings especially narrow with a slight inflexion of the posterior margin. Club joints comparatively long, the three together as long as the funicle joints united, pedical, and one-half of the scape. The three funicle joints usually subequal in length.

These two species belong to *Aspidiotiphagus* Howard, its generic characters as usually having narrow forewings with long fringe, a bare spot beneath the stigma, and the hind wings pedunculate.

Parasitic fungi: Prof. David Fung-yean Yen has listed four species of Ascomycetes namely *Hypocrella aleyrodis* (Webb) Sawada, *Ophinoectria tetraspora* Miyabe et Sawada, *Sphaerostilbe aurantiicola* (B. et Br.) Petch *S. fujikuroi* Miyabe et Sawada and S. *coccophila* Tul. Four species of Fungi Imperfecti are *Aschersonia aleyrodis* Webbar, *A. marginata* Ell. et Ev. *Cephalosporum lecanii* Zimmerman and *Verticillis parlatoriae* Sawada respectively. The writers did not make any survey about these fungi but we belief these parasitic fungi are very abundant during the wet season especially in the North of Taiwan.

IV. Chemical control study

The field trial of chemical control against black Parlatoria was carried out at Hsinten County near Taipei. Citrus variety was Tankan, seven year old. Before spraying, carefully examination of the infested tree, because the distribution of black Parlatoria was uneven, each treatment contained two trees including untrested (Check) ones totally 98 trees were selected. This experiment was subdivided into

two trials. The first trial was sprayed on August 23, 1962 and the second was sprayed on November 5, 1962 respectively, each tree was received 5 litter of spraying liquid both upper ane lower surfaces of leaves were sprayed completely as possible. After 10, 20, 30 days of spraying, 10 leaves of each tree were picked at randon and kept in refrigerator ready for examination.

When examining, the leaf was put under the binocular and the scale were taken off with needles from both sides of the leaf. If the scale body was fresh and light purplish in color as the alive and the body shrank, color changed and dried as dead.

The tested insecticides and their tested percentage of active ingredient were showed in tables I and II. Due to the dead scale still adhesiving on the leaf even though after heavy storm. Moreover, it took 7 generations a year and the dead scale accumulated so heavy on the same leaf, the alive scale was not so much, according to this examination of untreated 120 leaves, the mortolity of scale was around 70.57%. Therefore it was adopted Abott's formula to compute exact mortality due to receiving of each chemical treatment since the untreated or check plot was not computed in these tests.

According to the first trial, it showed that dimethoate 0.05, 0.075, 0.10%, parathion 0.05% and malathion 0.05% in combination with summer oil 1% were the best, the mortality was at least above 96%.

The second trial showed that summer oil 3% and parathion 0.05% with or without solvent were the best. The mortality was over 95%.

For safe, economic, efficacy, dimethoate 0.05% may be first recommended to control the black Parlatoria. However, summer oil 3% was also good but it was too expensive and may harm to the tree since the high content of oil. Parathion 0.05% was good but it was very dangerous to the operators, the next was malathion 0.05% in combination with summer oil 1% as had been accepted by the citrus growers for control this scale and other citrus pests already.

Table II: First Trial of Chemical Control Black Parlatoria

Chemicals and percentage of active ingredient		1st Exam.		2nd Exam.		3rd Exam.		Average
		No. of Obs.	Morty.	No. of Obs.	Morty.	No. of Obs.	Morty.	
Summer oil of CPC	1.00%	1013	12.07	960	22.29	1475	65.46	33.27
Summer oil of CPC	1.25%	964	21.77	1849	28.55	1443	46.36	32.23
Summer oil of CPC	1.50%	2158	28.09	1259	72.88	1492	48.66	49.88
Summer oil of Ihara	1.00%	1507	44.47	2273	28.15	1679	48.35	40.32
Summer oil of Ihara	1.25%	1503	41.70	849	41.50	1343	46.86	39.68
Summer oil of Ihara	1.50%	1129	57.04	919	55.75	1306	75.88	62.89
Base oil -S-2686	1.00%	1884	42.24	2174	61.04	1867	81.06	61.44
Base oil -S-2686	1.25%	1496	19.07	828	69.47	1685	83.47	57.33
Base oil -S-2686	1.50%	1230	10.06	752	65.82	936	76.31	50.73
Scalecine of Nihhon	1.00%	1399	33.51	1254	39.34	3191	80.24	51.03
Scalecine of Nihhon	1.25%	1007	46.48	936	52.72	1349	72.62	60.61

Scalecine of Nihhon	1.50%	1426	69.25	1045	84.47	1894	60.99	71.57
Triona Medium Soluble	1.00%	1551	22.20	1280	69.87	984	73.90	55.32
Spray oil of Shell Triona Medium Soluble	1.25%	1078	48.02	1137	74.99	1015	67.79	63.60
Spray oil of Shell Triona Medium Soluble	1.50%	1697	71.62	1173	73.05	1156	75.46	73.37
Spray oil of Shell Dimethoate	0.05%	852	62.46	1038	98.29	987	96.46	90.51
Dimethoate	0.075%	1165	86.49	910	99.30	1012	99.26	96.71
Dimethoate	0.10%	1089	70.33	1451	99.56	1830	100.00	93.95
Malathion	0.06%	932	44.11	951	66.65	1221	64.33	58.36
Malathion	0.10%	751	51.22	773	71.68	1368	77.25	66.72
Malathion 0.05%+Summer oil of CPC	1.00%	772	77.66	1191	99.12	1056	98.63	94.67
Sumithion	0.05%	712	56.61	826	85.34	969	83.94	80.22
Sumithion	0.10%	877	83.19	636	90.48	890	88.64	89.91
Lebaycid	0.05%	912	68.50	974	62.58	1655	60.52	60.08
Lebaycid	0.10%	1593	79.92	1269	59.54	1016	65.15	65.58
Parathion	0.05%	1460	95.33	1058	99.35	1584	98.02	98.05
Check		1207		1163		1416		

L.S.D. for Treatment 0.05=7.87, 0.01=10.50.

Table III: Second Trial of Chemical Control Black Parlatoria

Chemicals and percentage of active ingredient		1st Exam.		2nd Exam.		3rd Exam.		Average
		No. of Obs.	Morty.	No. of Obs.	Morty.	No. of Obs.	Morty.	
Summer oil of CPC	2.00%	1709	32.17	2217	68.46	1531	66.17	55.60
Summer oil of CPC	2.50%	1222	31.90	1379	79.12	1145	86.17	65.73
Summer oil of CPC	3.00%	693	91.61	791	96.39	862	100.00	96.00
Dimethoate	0.025%	1589	28.87	1739	87.98	1312	71.26	62.70
Dimethoate	0.0375%	1523	42.02	1629	94.59	789	89.68	75.43
Gusathion	0.025%	1271	20.57	1955	21.83	1155	—	21.20
Gusathion	0.05%	1004	—	1016	64.19	959	68.31	66.25
Gusathion	0.10%	1066	57.21	1136	81.05	1101	79.79	72.68
Folithion	0.05%	1525	—	1218	23.09	987	11.48	17.26
Folithion	0.10%	1624	18.73	1066	52.80	926	45.44	38.99
Diazinon	0.025%	1116	36.54	1100	66.06	975	46.85	49.87
Diazinon	0.05%	1207	21.59	987	72.13	765	48.48	47.40
Nuvan (DDVP)	0.05%	1570	—	1258	48.69	1554	—	48.69
Nuvan (DDVP)	0.10%	1086	—	1170	45.11	1126	24.33	33.10
Parathion	0.025%	1192	45.03	923	78.39	1513	71.13	64.85
Parathion solvent less	0.025%	1365	12.91	1057	91.02	922	85.14	63.02
Parathion solvent less	0.05%	908	39.06	854	95.19	918	95.80	76.68
Parathion solvent	0.025%	874	67.78	840	87.19	788	80.43	78.46
Parathion solvent	0.05%	1288	64.19	998	98.25	1115	95.72	85.05
Dimecron	0.05%	1398	14.60	1470	29.20	1713	8.27	17.35
Dimecron	0.10%	1674	—	1330	36.73	1264	5.82	21.27
Check		1533		1531		1850		

L.S.D. 0.05=19.08, 0.01=25.53.

Summary

The black Parlatoria, *Parlatoria zyziphus* (Lucas) was the most difficult to control by insecticides owing to its scale was so flat and firmly stick on the leaf, twig or fruit peel lack of effective parasitic wasps or other groups of natural enemies. In consequence of its infestation was severe over other scale insects infested at present. Therefore the writers reviewed and tried insecticlede control of this species, the results may be summaried in the following.

Species and its generic characters had been described and differences among other species belonging to the same genus were presented in the key. The hosts seemed to limit various varieties of Citrus only on this island.

It took 7 generations a year, morphology of each stage was briefly described. Durations of egg, 1st, 2nd, 3rd stadium, oviposition period and one generation were 2–4, 6–13, 13–30, 11–24, 7–18, 42–93 days respectively.

There were 4 species of parasitic wasps namely *Aphytis chrysomphali* (Mercet) *A. proclia* (Walker), *Aspidiotiphagus citrinus* Craw and *A. lounsburyi* (Berlese and Paoli) recorded but the percentage of parasitism was very low and not over 2%. The morphology of each parasitic wasps was also briefly described.

1, 1.25, 1.5% of five sauces of summer oil, 2, 2.5, 3% of CPC summer oil, 0.015, 0.0375, 0.05, 0.10% dimethoate, 0.05, 0.1% malathion alone, 0.05% malathion plus 1% CPC summer oil, solvent less and solvent parathion 0.025, 0.05, 0.1%, 0.05, 0.1% lebaycid, folithion, dimecron, nuvan (DDVP) and gusathion, diazinon, nuvan (0.025% each extra) were teated in the field, Among them, only 0.05% parathion, dimethoate and 0.05% malathion plus 1% summer oil or 3% summer oil alone were good and the mortality of the adult was over 95% and could be accepted for recommendation to control this species in Taiwan except parathion in present condition.

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黑 點 介 殼 蟲

張良傳　陶家駒

中 文 摘 要

黑點介殼蟲 Parlatoria zizyphus (Lucas) 爲目下本省最難防治之柑橘害蟲，因其介殼扁平，堅固枝，葉或果上，雖用力或經塗蠟手續，均不易擦去，寄生蜂亦難寄生，一年發生代數多達七代，疊積果皮，葉片或嫩枝上，不但有損外觀，果實不能出口或上市，且被害之枝葉，往往枯落，損害不少。

防治方法：現用 1%夏油加用 0.05% 馬拉松乳劑，或用 0.05% 巴拉松防治，可以成功，但前者成本高而後者對使用者有危險。本文所述將市上現有之有機磷殺蟲劑，作一田間比較試驗，發現 0.05% 大滅速乳劑，可以代替極毒之巴拉松或與夏油加用馬拉松之煩，將來如能對於大滅速作合理價格之調整，可資採用防治。

黑點介殼蟲之種屬特徵與其同屬共害柑橘之種類特點，黑點介殼蟲四種寄生蜂之種屬特徵與黑點介殼蟲之生活習性，地理分布均有扼要說明，末附參考文獻，可助經濟昆蟲學者不少參考之處。

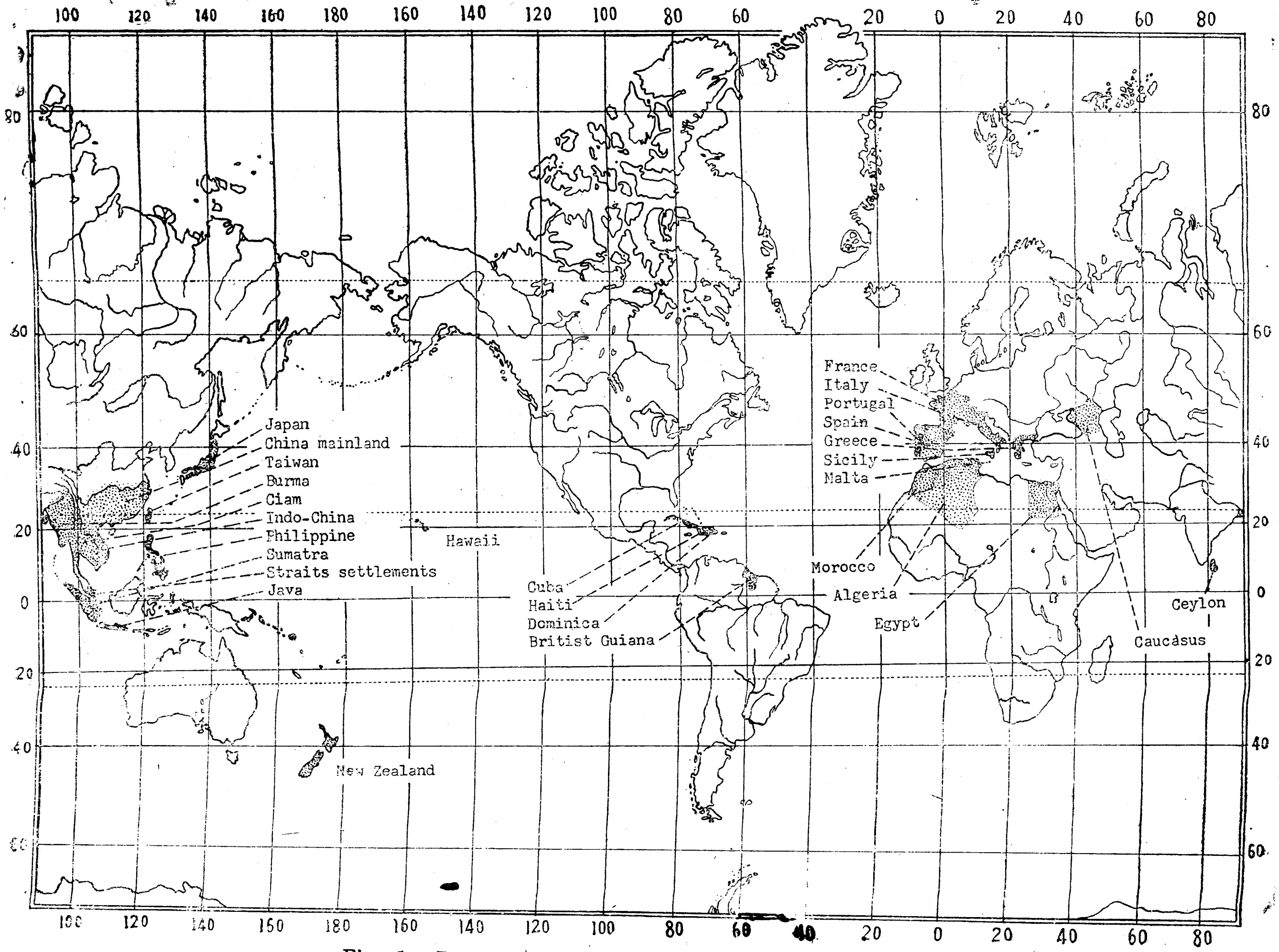

Fig. 1. Parlatoria zizyphus (Lucas) distributional map.

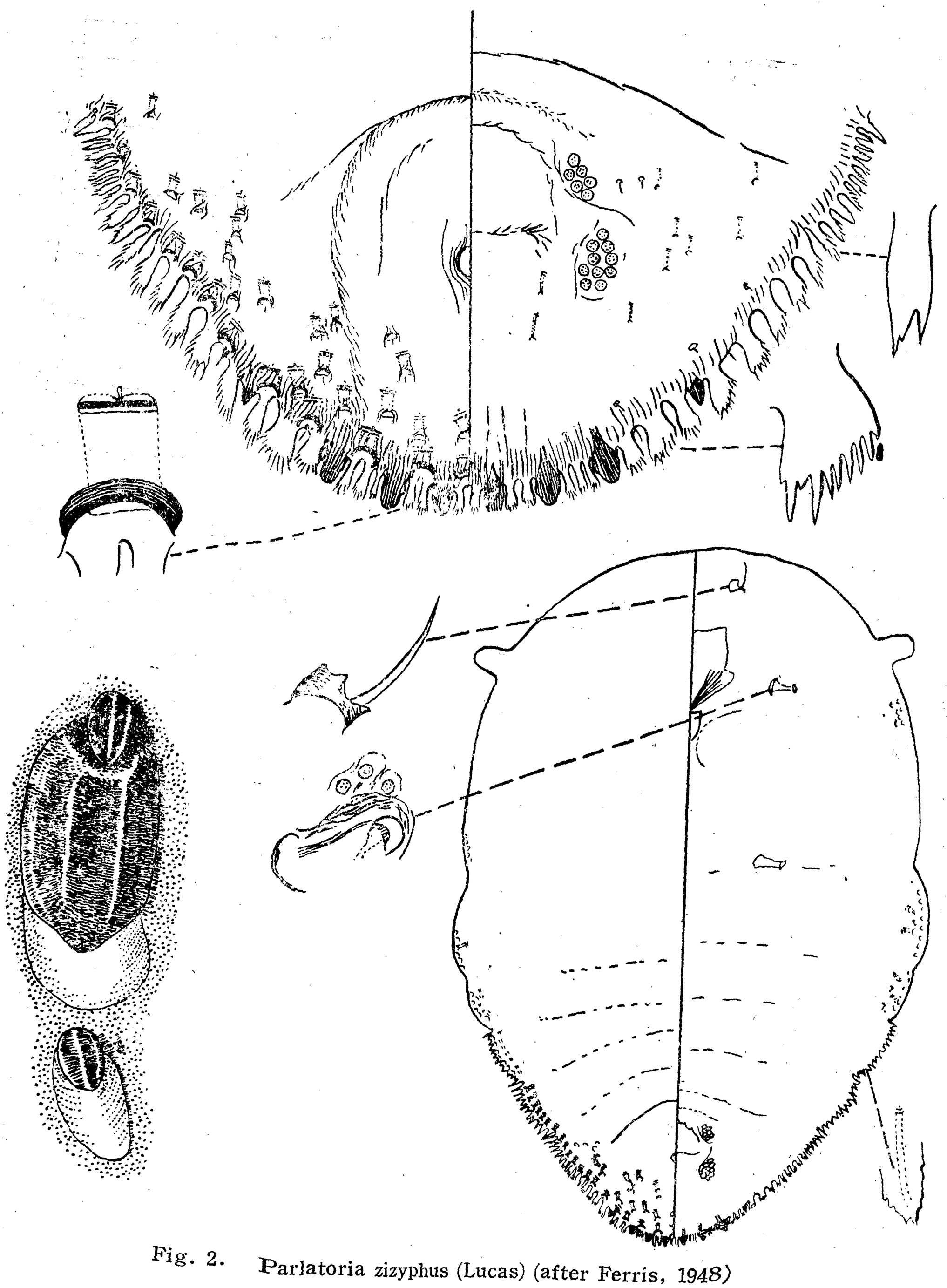

Fig. 2. Parlatoria zizyphus (Lucas) (after Ferris, 1948)

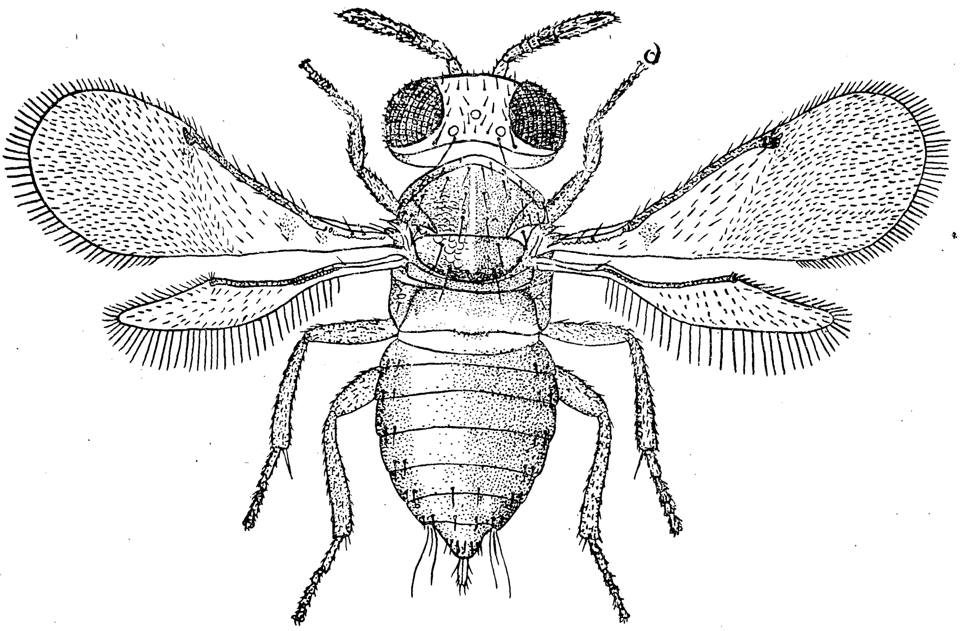

Fig. 3. Aphytis chrysomphali (Mercet) (after Compere, 1955)

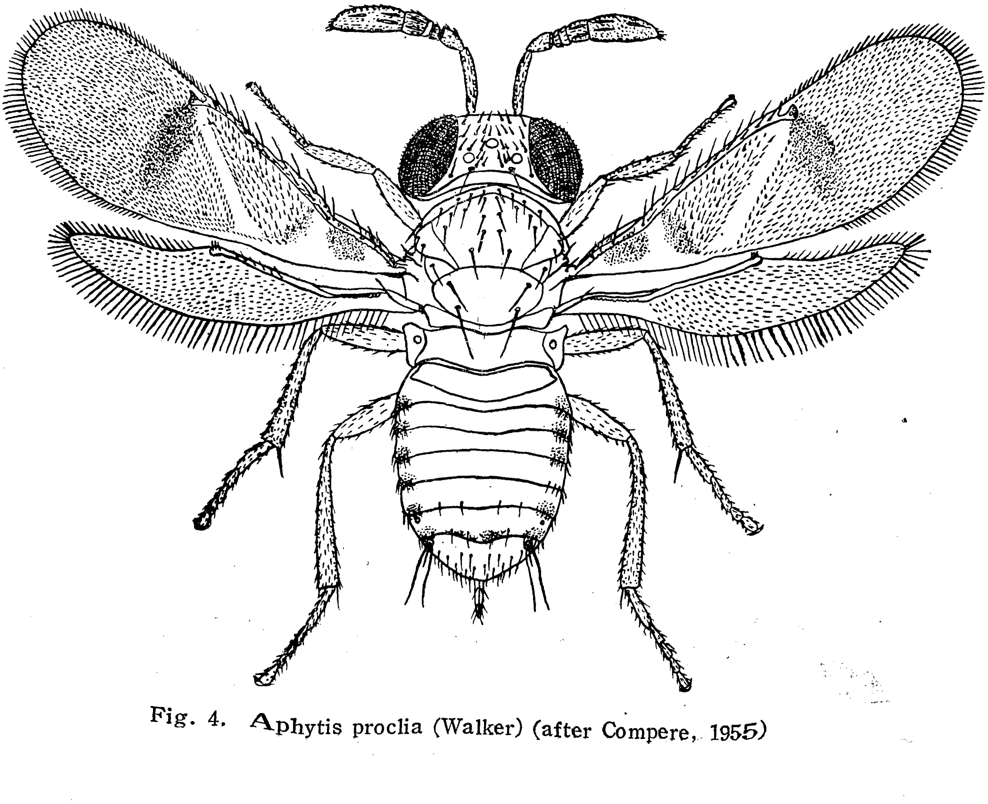

Fig. 4. Aphytis proclia (Walker) (after Compere, 1955)

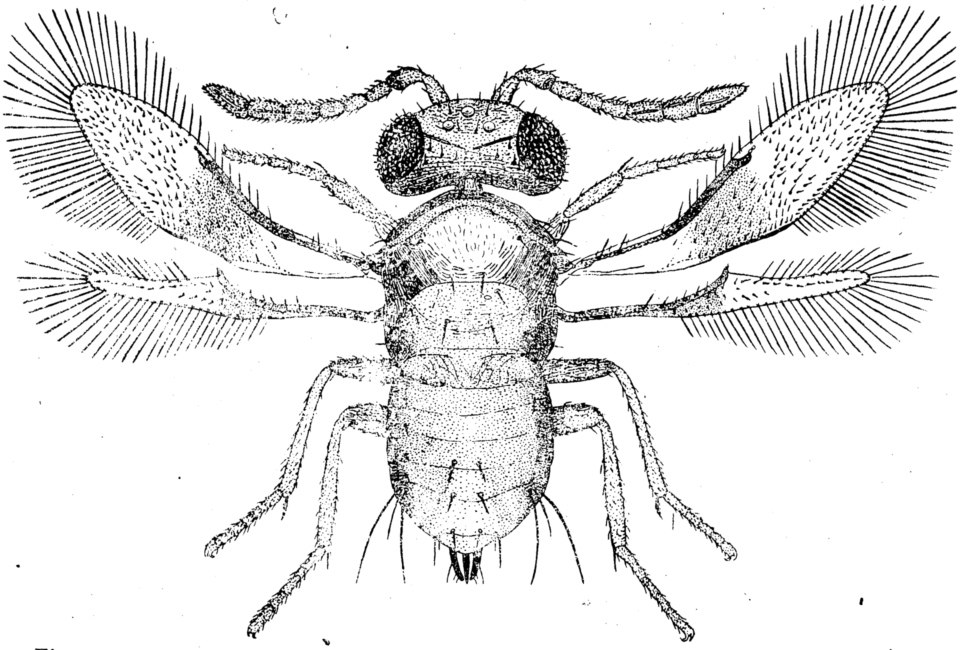

Fig. 5. Aspidiotiphagus citrinus (Craw.) How. (after Malenotti Ettore, 1918)

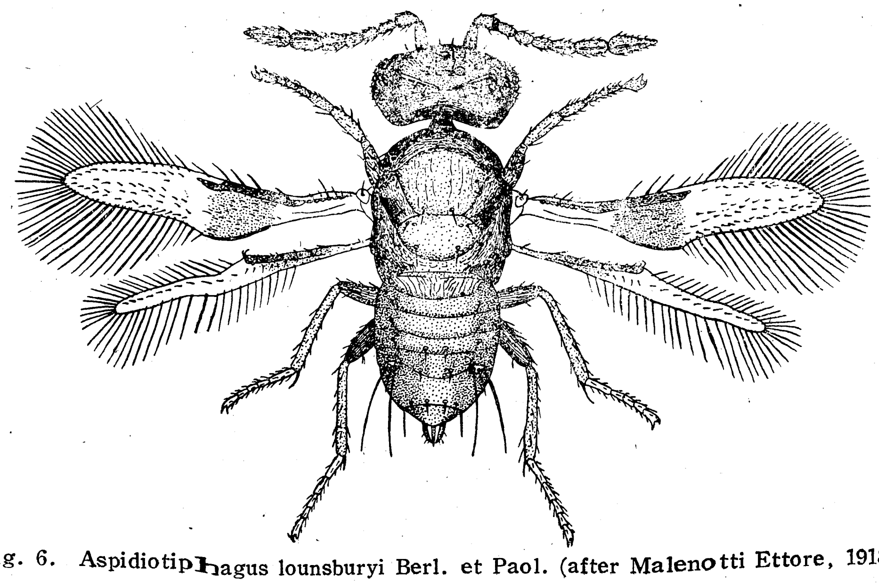

Fig. 6. Aspidiotiphagus lounsburyi Berl. et Paol. (after Malenotti Ettore, 1918)

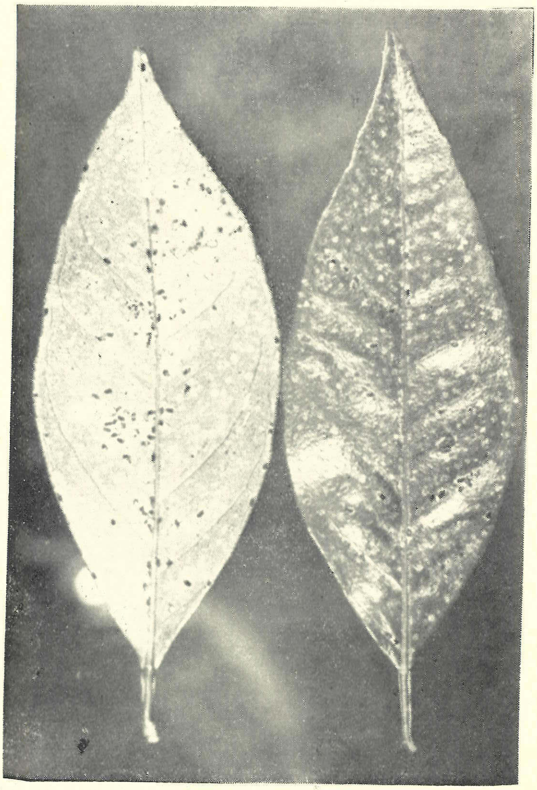

Fig. 7. Citrus leaf infested with black parlatoria

Fig. 8. Citrus fruit infested with black parlatoria

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